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AN

IDEA

OF A

PHYTOLOGICAL HISTORY
Propounded.

Together with a Continuation of the

ANATOMY of VEGETABLES,

Particularly profecuted upon

ROOTS.

And an Account of the

VEGETATION of ROOTS

Grounded chiefly thereupon. *K*

By NEHEMIAH GREW M. D. and Fellow
of the *Royal Society*.

LONDON,

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Churn in *St. Pauls Church-yard*; 1673^e

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For: Books



To the Right Honourable

WILLIAM

Lord Viscount BRONCKER

THE
PRESIDENT,

And to the rest of the Fellows of the
ROYAL SOCIETY.

Right Honourable and most Illustrious,

I*F the Dedication of Books were not in use, yet here I think I might have been a precedent. The promotion of Phytological Science is one part of Your Work; and 'tis You have called me to the management of this part, for some time have intrusted me*

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The Epistle Dedictory.

me herein, and by Your most benign and candid acceptance of what I have performed thus far, have encouraged me herunto: I therefore present but Your own into Your hands.

The great Honour and Advantage of Your Fellowship, I first obtained by Mediation of the late most Reverend Bishop of Chester; whom I cannot name without saying thus much of him, That He was a Person of that eminent and happy Worth, which as it was too good to fear envy, so is it too great to need an Elogie.

With Him it was You were pleased to approve of me for that Undertaking which I have here begun. Had I consulted my own abilities altogether, I should scarcely have ventured upon it; seeing very little for which I could think well of my self, seeing that I had learned upon good grounds, to think of You with greatest Honour. But I also considered; That to insist hereon too much, might

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The Epistle Dedicatory.

might be a reflection upon Your Judgments, who had thought fit to make choice of me. And, That You were not more the Patrons of Wit, than of Industry, and of all who shall endeavour to find out, or to confirm the Truth of Things. Whilst, I looked upon Nature as a Treasure so infinitely full, that as all men together cannot exhaust it; so no man, but may find out somewhat therein, if he be resolved to Try.

In compliance therefore with Your Commands, I have hereunto devoted my self. These adding force to my own desires of being somewhat instrumental to the improvement of Medicinal and other wholesom Knowledge: if peradventure, as we increase herein, we may become better and more happy. As to which Improvement, though I could not hope, yet I would not despair. I have already prepared the Soil, and made some Plantation; what remaineth behind, and the Vintage of the whole,

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will depend much upon the continued Influence of Your Beams : for how improving soever the Stock may be, yet the Fruit cannot but be somewhat matured upon which You are pleas'd to shine. I am also confident, that the same Nobility and Goodness which accept the endeavours, will likewise pardon the faults, of

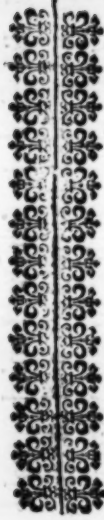
Your most humbly

and most sincerely

devoted Servant

Nehemiah Grew.

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PREFACE.

HAving divers years since directed my thoughts towards the Anatomy of Vegetables; what Observations I had from time to time occasionally made, I published some time since. In making whereof, I proceeded from the Seed sown, throughout all the Parts, to the Seed again. Subjoining to the Anatomy of every Part, my thoughts of their œconomical Uses thence deduced.

Hitherto I had examined the Parts chiefly by the bare eye: some few Observations excepted, which were made by the Microscope. And this

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I did, to the intent I might make proof, both for my self and others, how far it is possible to go with the eye, without the help of Glasses: proposing afterward to make the utmost use of those also.

Immediately after the Publication of These, a Discourse from the Learned *Malpighius* (to whose most ingenious and accurate industry the World is much beholden) was presented to the *Royal Society* upon the same Subject, *Decemb. 7. 1671.* and Dated at *Bononia, Novemb. 1. 1671.* By whose Suffrage I was glad to see the Truth of my Observations all along confirmed; his very little differing from mine, though He hath every where made use of the Microscope. As for the Air-vessels, (which he calls the *Fistulae Spirales*) although I have long since taken notice of them, as those which, being much larger than the rest, are more easily discoverable; yet the

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the manner of their Spiral Conformation (not observable but by a Microscope) I first learned from Him, who hath given a very elegant Description of them. He communicates not many of his thoughts of the æconomical Use of the Parts. And some Things observable of the Parts of the Flower, Fruit, and Seed, not there found, He may possibly reserve by him amongst others. I could heartily wish He would have published his Discourse, but that He is unwilling to, before it be furnished with Figures: for which reason I thought good to give this account of it.

Presently after the Impression of my first Endeavours, I resolved upon a further prosecution of them. The Series of my Thoughts and Observations following thereupon, I have distributed into three Parts, and in obedience to the Command of the *Royal Society* have now made publick. Which

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Which I have the more willingly done, that others may hence take occasion the better to consider, what they have to do as well as I. For we may as well commit the Government of the World, as the Management of Philosophy to any one : and much better, since Things are far more numerous than Men, and no less various and out of sight.

For the first, it is as comprehensive as I could at present make it. I doubt not, but that further Means and Inquiries may be suggested ; and perhaps no way better than in the prosecution of these : the generation of Experiments being like that of Discourse, where one thing introduceth an hundred more which otherwise would never have been thought of.

The second is the prosecution of what I had before begun, and purpose to continue, both of the Root, and all the other Parts. For this I apologize

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apologize not; for what I here represent, are neither Words, nor probable Things; but both the real and the visible Works of God.

As to the last, I only desire it may be remembred, That while I speak of Natural Causes, and particularly of those of Vegetation, I intend only the Material ones, which (whatever others, besides the first, be assigned) we must allow to be so qualified as to become instrumental thereto; unless it be denied that there is such a Thing as a Material Cause.

If it be asked why I insist so much on These, whilst I am silent of the Existence, Nature, and Energy of the *Anima Vegetalis*, the *Vis formatrix*, the *Vis Motiva*, or other Immaterial one? To this, because I am willing to suppose the Question soberly propounded, I answer; That it is not for that I have had no thoughts hereof; but because I do not find they do so well answer

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answer the Scope whereto I am more obliged: for the investigation of the Nature of any other Secondary Causes, than such as are Material, cannot be so useful to one that is considering the Nature of a Disease, or Compounding or Applying a Remedy thereunto. And if any of the Principles or Discourses of *Cartesius*, *Gassendus*, or others about Material Causes, may, upon a right Judgment made, be found culpable, I am not about to answer for them.

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THE UNIVERSITY OF CHICAGO

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AN
IDEA

OF A
PHYTOLOGICAL HISTORY
Propounded.

THE FIRST PART.

IF we take account of the degrees whereunto the knowledge of Vegetables is advanced, it appeareth, That their Descriptions, Places, and Seasons are with good preciseness and curiosity set before us. Likewise, that we are informed of the Natures and infallible Faculties of many of them. Whereunto so many as have assisted, have much obliged their Posterity.

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By due reflection upon what they have performed, it also appears, what they have left imperfect, and what undone. For the Vertues of many Vegetables are with much uncertainty, and too promiscuously ascribed to them. And of the Vertues of many they are altogether silent. And although, for the finding out and just appropriation of them, they have left us some Rules, yet not all. The Descriptions likewise of many are yet to be perfected; as also their Draughts, especially as to their Roots. And their proper ranks and affinities much undetermined. But for the Reason of Vegetation, and the Causes of all those infinite varieties therein observable (I mean so far as matter, and the various affections hereof are instrumental thereto) almost all men have seemed to be unconcerned.

That nothing hereof remaineth further to be known, is a thought not well calculated. For if we consider how long and gradual a Journey the knowledge of Nature is, and how short a time we have to proceed therein; as on the one hand, we shall conclude it our ease and profit to see how far others have gone before us: so shall we beware on the other, that we conceive not unduly of Nature, whilst we have a just value for those who were but her Disciples

Part I. Phytological History. 3

ciples and instructed by her. Their time and abilities both being short to her, which as she was first designed by Divine Wisdom, so may her vast dimensions best be judged of, in being compared therewith. It will therefore be our prudence, not to insist upon the invidious question, which of her Scholars have taken the fairest measure of her; but to be well satisfied, that as yet she hath not be circumscribed by any.

Nor doth it more behove us to consider how much of the Nature of Vegetation may lie before us yet unknown, than to believe a great part thereof to be knowable: not concluding from the acknowledged, much less supposed insuccessfulness of any mens undertakings; but from what may be accounted possible as to the Nature of things themselves; and from Divine Providence, by infinite ways conducting to the knowledge of them. Neither can we determine how great a part this may be; because it is impossible to measure what we see not. And since we are most likely to under-measure, we shall hereby but intrench our endeavours, which we are not wont to carry beyond the Idea which we have of our Work.

And how far soever this kind of Knowledge may be attainable, its being so far also

worthy our attainment will be granted. For beholding the many and elegant varieties wherewith a Field or Garden is adorned, who would not say, That it were exceeding pleasant to know what we see; and not more delightful to one who has eyes, to discern that all is very fine; than to another who hath reason, to understand how. This surely were for a man to take a true Inventory of his Goods, and his best way to put a price upon them. Yea it seems, that this were not only to be partaker of Divine Bounty; but also, in some degree, to be Copartner in the Secrets of Divine Art. That which were very desirable, unless we should think it impertinent for us to design the knowing of that, which God hath once thought fit to do.

If for these and other reasons an inquiry into the Nature of Vegetation may be of good import; it will be requisite to see first of all what may offer it self to be inquired of, or to understand what our Scope is; that so doing, we may take our aim the better in making, and having made, in applying our observations thereunto. Amongst other inquiries therefore, such as these deserve to be proposed. First, by what means it is that a Plant, or any part of it, comes to grow; a Seed to put forth a Root and Trunk;

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Trunk ; and this, all the other parts to the Seed again ; and all these being formed, by continual nutrition still to be increased. How the Aliment by which a Plant is fed, is duly prepared in its several parts ; which way it is conveyed unto them ; and in what manner it is assimilated to their respective Natures in them all. Whence this growth and augmentation is not made of one, but many differing degrees, unto both extremes of small and great ; whether the comparison be made betwixt several Plants, or the several parts of one. How not only their sizes, but also their shapes are so exceeding various ; as of Roots, in being thick or slender, short or long, entire or parted, stringed or ramified, and the like ; of Trunks, some being more entire, others branched, others shrub'd ; of Leaves, which are long or round, even-edg'd or escallop'd, and many other ways different, yet always flat ; and so for the other parts. Then to inquire, what should be the reason of their various Motions, that the Root should descend ; that its descent should sometimes be perpendicular, sometimes more level ; that the Trunk doth ascend ; and that the ascent thereof, as to the space of time wherein it is made, is of different measures ; and of divers other Motions, as they are observable

ble in the Roots, Trunks, and other parts of Vegetables. Whence again, these Motions have their different and stated Terms; that Plants have their set and peculiar seasons for their spring or birth, for their full growth, and for their teeming, and the like. Further, what may be the causes as of the seasons of their growth, so of the periods of their lives; some being annual, others biennial, others perennial; some perennial both as to their Roots and Trunks; and some as to their Roots only. Then, as they pass through these several seasons of their lives, in what manner their convenient feeding, housing, cloathing, or protection otherwise, is contrived; wherein in this kind and harmonious oeconomy, one part may be officious to another for the preservation of the health and life of the whole. And lastly, what care is taken, not only for themselves, but for their posterity; in what manner the seed is prepared, formed, and fitted for propagation: and this being of so great concernment, how sometimes the other parts also, as Roots in putting forth Trunks, Trunks in putting forth Roots, yea in turning oftentimes into Roots themselves; whereof I shall in the following Discourse give some instances: with other Heads of Inquiry of this kind.

Nor

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Nor are the Natures, Faculties, and Contents of Vegetables less various, or a particular inspection hereinto of less concernment. For since all, or most, seem to grow in the same manner, with one Sun, one Rain, indifferently well upon one Soil, and to outward appearance to have the same common parts; it may be asked, How it comes to pass, that their liquors, or other contained parts are of such different kinds, one being watry, another winy, a third oily, a fourth milky, and the like. How also there is such a variety in their sensible qualities, as their Colours, Tastes, and Smells; what those Materials are, which are necessary to the being of these qualities; and those formalities wherein their Essence doth consist; as what it is that makes a Plant or Flower to be white or red; fragrant or fetid; bitter or sweet; or to be of any other colour, smell, or taste. In like manner their Faculties and Powers, what that is or those things are by which they are constituted, as whence one becomes purgative, another vomitory, a third Diaphoretick, &c. These, I say, with many other particular inquiries depending hereupon, as they cannot but much oblige the reason of man to be obsequious to them; so by bringing in at least some satisfaction with no less

reward

reward it. Especially if it be withal considered, that besides our satisfaction as to the Nature of Vegetation, some further light to divers other parts of Knowledge may likewise hence arise.

For since the present Design will engage us to an accurate and multifarious observation of Vegetables; we may hereby be enabled to range and sort them with more certainty, according to the degrees of their affinity. And all Exoticks, Plants or parts of Plants, may probably be reduced to some such Domesticks, unto which they may bear the best resemblance. Again, it may frequently conduct our minds to the consideration of the state of Animals; as whether there are not divers material agreements betwixt them both, and what they are. Wherein also they may considerably differ, and what those things are which are more essential to their distinguishment. And besides, not only to compare what is already known of both, but also by what may be observed in the one, to suggest and facilitate the finding out of what may yet be unobserved in the other. So also the consideration of the Colours, Smells, and Tastes of Vegetables, may conduce to the Knowledge of the same Qualities in general; or of what it is that constitutes them such in any

Part I. Phytological History. 9

any other body : not as they are actually received by sense ; but so far as such Materials or external Circumstances are requisite to their becoming the adequate objects thereof. It may lead us also to inquire into further ways of Cultivation, with respect to the whole Plant, or to the Flower, Fruit, or other part : To amend them as to their Sizes, Colours, Tastes, Fruitfulness, or otherwise : To think of other ways of Propagation, or to apply those already known to other Vegetables than hath been used. Likewise the knowledge of their Mechanical uses may hereby be enlarged ; both as to the reason of their use, in such particular Trades and Manufactures, already known ; and the discovery of other uses yet unknown. As also their Alimential, with respect both to Meats and Drinks ; the preparation of some, and the finding out of others. But especially their Medicinal ; some Vegetables which have hitherto been neglected, may be applied to use ; the reverted uses of some, and the confused uses of others may be rectified. What may best correct their Malignancies, or inforce their Vertues ; when needful to add the preparations of Art to that of Nature ; how to enlarge those of Art, and rectifie those which are indeed inartificial, may hereby be better con-

conjectured. The knowledge of all which, that we may know how far it is accessible, and what probable approaches may be made towards it ; those several means I have thought of, and suppose necessary thereunto, are next to be proposed.

Reflecting then upon the present Design, and seeing this to lie wide ; we shall in the first place conclude the Means attending thereon should do so likewise. Wherefore although some may present themselves unto us as more promising ; yet let us suppose what others also, were they hereunto engaged, each according to his sense and Genius, would possibly make choice of. Believing, that although considering men may vary in the approval of their own sense and notion ; yet not always meerly, because it is their own, but because each may probably see somewhat more in his own, than others do. Wherefore it will be our surest Logick to conclude, not because no Mean may be approved by all ; that all should be rejected ; but rather because each may be approved by some, that therefore all be made choice of.

And first of all, whatever is of more external consideration, as the Figures, Proportions, Motions, Seasons, Situations of Vegetables, and of their several parts, should

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should be observed. In doing which, a particular survey of all their varieties should be taken. And then a comparison made betwixt these and the several Plants or parts of Plants whereof they are the properties. To the end we may, if possible, be thereby conducted to find out what other sensible, or more reclude property any of them may agree together in. For it is not more certain, that the three Angles of every Rectilinear Triangle, because all waysequal to two Right Angles, are therefore, if put together, always the same: than that one property agreeing to divers Vegetables, should have one cause: for although the scope and end may vary, yet the cause, as it is the cause of that property, must be one: and consequently must also import some Identity in the Nature of all those Vegetables wherein it acts. Wherefore by thus comparing of them, we shall be able more exactly to state the Orders and Degrees of their Affinities, better to understand both the Causes and Ends of their Varieties, and more probably to conjecture of their Natures and Vertues.

First then the various figures of their several parts should be observed; and that with respect both to the forms, and the positions by which their Roots, Trunks, Branches,

ches, Leaves, Flowers, Fruits, and Seeds may vary or agree; and those several Lines by which both the said Varieties are draw. In which of these parts the agreement chiefly lies; this being both more observable, and material in some of them, less in the Root, more in the Flower or Seed. And in how many of these parts together, whether one, more, or all. By both which the Orders and Degrees of Affinity may be accounted, either as to what we strictly call Kindred, or else Analogy. Thus all Strawberries are 'akin together in the first degree, with Cinquefoyl in the second, with Tormetil in the third, and with Avens, &c. in others more remote. So Agrimony hath alike Analogy unto Strawberry, as Goats-Rue hath to Claver; and Strawberry the like unto the Rasp, as Gooseberry to the Vine, or Burnet to the Rose. So all Pulse are not only of kin in their several degrees to one another; but likewise to almost all kinds of Trefoyls, as Melilot, Foenugreek, and the common Clavers themselves; as by comparing not only their Leaves, but Flowers, Seeds, and Cods together may be evident. For the several parts of the flower of a Trefoyl are so many more Flowers, containing so many Cods of small Seeds, all in shape agreeable to the Flowers,

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Flowers, Cods, and Seeds of Pulse.

From hence likewise the Natures of Vegetables may be conjectured. For in looking upon divers Plants, though of different names and kinds; yet if some affinity may be found betwixt them, then the nature of any one of them being well known, we have thence ground of conjecture as to the nature of all the rest. So that as every Plant may have somewhat of nature individual to it self; so as far as it obtaineth any visible communities with other Plants, so far may it partake of common Nature with those also. Thus the Wild and Garden Cucumers have this difference, that the one purgeth strongly, the other not at all; yet in being Diuretick, they both agree. The Natures of Umbelliferous Plants we know are various; yet 'tis most probable that they all agree in this one, *scil.* in being Carminative. The several sorts both of Corn and Grasse are all 'akin; there is no doubt therefore but that the seeds of Grasse themselves (of Rye and Oats it is tryed) if it were worth the while to order them, as Barley, would yield an inflammable Spirit. So likewise the several kinds of Pulse, as is said: for which reason I question not, but that in some cases wherein Ciches are esteemed a good Medicine, a Decoction of the

the better sort of Pease, especially that we call Sugar-Pease, may go beyond them. As doth also the flower of Beans that of the seeds of Fœnugreek, even there where they are accounted excellent. So Tulips, Lillies, Crocuses, Jacynths, and Onions themselves, with many others in their several degrees, are all allied. If therefore Crocuses, Onions, Lillies agree in one or more faculties, then why may not all the rest? as in being anodyne; or in some other common Nature, whereby in their Vegetation, their parts are governed and over-ruled to one common or analogous form.

The Proportions likewise amongst the several parts of Vegetables, for the same reasons, deserve to be observed; the comparison being made both betwixt the parts of several Plants, and the several parts of one. And here again, either betwixt any two of the parts, or any one of them, and the whole besides, or all the rest put together. So some larger Seeds, produce a small Root; as those of Cucumer: and others smaller, produce one very great; as those of Briony. Some Plants, as the Melon, though themselves but very slender, yet have a vast and bulky fruit; others again, as Thistles, and many yet more substantial, have no other fruit besides their seed.

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seed. So the seeds of all Pulse, and especially the Garden Bean, though very large, yet produce but a small Plant : but those of Foxglove, Mullen, Burdock, Sun-flower, &c. being themselves much less, do yet produce a far greater. And especially those seeds which are inclosed in the thicker sort of Cover, (analogous to that I have elsewhere called the Secondine) as that of Peony ; whose seed so called, is only the Nest wherein the true and real seed is lodged, no bigger than a little Pins head : which is also observable of the seeds of divers other Plants. These and the like portions, as they lie betwixt the several parts, should be noted : and to what plants or parts especially, any of them may agree : comparing also in what other kind of properties an agreement betwixt the said parts may be found : that so doing, we may, if possible, amongst all their individual Natures, be instructed to single out those common ones, which are concomitant to such agreeing properties.

The several Seasons also of plants and of their parts should be considered. Observing at what particular times of the year any of them chiefly spring, early or late. The times wherein they germinate ; whether for some space only, or all the year long. Wherein

Wherein they spring after sowing; or flower after springing, sooner or flower. Which flower the first year, or not till the second. Which before the Leaves, or afterwards. The maturation of the fruit or seed, how long after the flower, and the like. All or some of which varieties being laid together, we may probably conjecture the causes thereof; and the Natures of the Plants in which they are seen; *scil.* as such a degree of heat may be necessary for the fermentation, or the better distribution of the sap of such a Plant, or the impregnation of the Air to be mixed therewith, or the due disposing of the Soil to render the most convenient aliment thereunto.

The proper Places also of Plants, or such wherein they have from their seeds or other way of propagation, a spontaneous growth, should be considered. And that as to the Climate, whether in one colder, temperate, or more hot. The Region, Continent, or Island. The seat, as Sea or Land, watry, boggy, or dry; Hills, Plains, or Vallies; open, in Woods, or under Hedges, and the like. From whence in like manner as from their seasons, their particular Natures may be directed unto: in that so far as we may conjecture the nature of such an Air, Soil, or Seat, we may also of such a Plant to which they are congenial.

So

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So likewise, those many varieties observable in the Motions of Plants and of their parts, both kinds and degrees; Ascending, Descending, and Collateral; Rectilinear, and Spiral Motions, should be noted; to what Plants they agree, and wherein any of them may be analogous to those of Animals. And in a word, any other forensick properties of Plants. And then to compare them all together, both being necessary. For thoughts cannot work upon nothing, no more than hands; he that will build an house, must provide Materials. And on the contrary, the Materials will never become an house, unless by certain Rules he joyn them all together. So it is not simply the knowledge of many things, but a multifarious copulation of them in the mind, that becomes profitable of further knowledge. And thus much for the first general Mean.

The next which I propose, and that a most necessary one, is Anatomy. For when upon the dissection of Vegetables, we see so great a difference in them, that not only their outward figures, but also their inward structure is so elegant, and in all so various, it must needs lead us thus to think, That these inward varieties were either to no end; or if they were, we must assign to what. To imagine the first, were exceeding

ing vain ; as if Nature, the Handmaid of Divine Wisdom, should with her fine Needle and Thred, stitch up so many several Pieces, of so difficult, and yet so groundless a Work. But if for some end, then either only to be looked upon, or some other besides. If for this only, then this must be such as in respect whereof, her work is at no time, nor in any degree frustrate ; the contrary thereunto is most manifest. For although men do every where with frequent pleasure behold the outward elegancies of Plants ; yet the inward ones, which generally are as precise and various as the outward, we see how usual it is for the beholding of these to be omitted by them. And besides, when we have observed Natures work as well as we can, it may be no impediment to our best endeavours to believe, that somewhat of it will still remain behind unseen. So that if to be seen, were the only end of it, it must needs be wholly frustrate, as to the greater number of men, and in some part as to all. Wherefore we must suppose some other ends of the said varieties, which should have their effect, and so these not be in vain, whether men beheld them, or not ; which are therefore such as have respect to Vegetation : that the Corn might grow so, and the

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the flower so, whether or no men had a mind, leisure, or ability to understand how.

If then the Anatomy of Vegetables be so useful a Mean, we ought not to streighten it, but to force this as well as the rest to its utmost extent. And therefore first of all, to go through all the parts, with equal care, examining the Root, Trunk, Branch, Leaf, Flower, Fruit, and Seed. Then to repeat or retrograde the Dissection from part to part: in that although the best Method of delivery, for clear discourse, can be but one, according to that of Nature, from the seed forward to the seed: yet can it not but be useful for that of Dissection to proceed to and fro; somewhat or other being more visible in each several part, from whence still an *Item* may be taken for the ushering in the observation of it in the other. To examine again, not only all the parts, but kinds of Vegetables, and comparatively to observe divers of the same size, shape, motion, age, sap, quality, power, or any other way the same, which may also agree in some one or more particulars as to their interior structure; and to make this comparison throughout all their parts and properties. To observe them likewise in several seasons of the year, and in several

ral ages of the Vegetables, and of its parts; in both which divers of them may be noted to change not only their dimensions, but their Natures also; as Vessels do into Ligaments, and Cartilages into Bones sometimes in Animals. And to do all this by several ways of Section, oblique, perpendicular, and transverse; all three being requisite, if not to observe, yet the better to comprehend some things. And it will be convenient sometimes to break, tear, or otherwise divide without a Section. Together with the Knife it will be necessary to joyn the Microscope, and to examine all the parts, and every way, in the use of that. As also, that both immediate and microscopical Inspections be compared; since it is certain, that some things may be demonstrated by reason and the eye conjunct, without the Glass, which cannot be discovered by it; or else the discovery is so dark, as which alone may not be safely depended on.

By these several ways of Inspection it will be requisite to observe their compounding parts, as simply considered, and as variously proportioned, and disposed. As simply considered, to note their number, what, and whether the same in all: their kinds, wherein different in the same, or divers Vegetables:

Original,

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Original, in part, or in whole: Structure, as to their Contexture and their Cavities; their Contexture, within themselves severally, and as joyned together: their Cavities, as to their size, shape, and number; in which a great variety will be found. Next their Positions one amongst another, which are also various; as Anterior, Posterior, Collateral, Surrounding, Mediate, Immediate, Near, Remote; both as they respect the several parts, and the several portions of one: And all these, as few or more, these or others of them may be diversly compounded together. And then the proportions they bear one to another, whether as to minority, equality, or excess; each part compared with each, and that as to the several degrees appearing in the said proportions; the varieties whereof may be exceeding numerous. For if we should suppose but four considerable parts generally constitutive of a Vegetable, these four produce a variety four ways; first, when one is unequal, and then it produceth only four varieties; and those two ways, *scil.* when one is greater, and the other three equal and less; or when one is less, and the other three equal and greater. Secondly, when two be unequal, and then they produce six varieties. Thirdly, when three be unequal,

equal, which produceth twelve varieties. Or lastly, when all four be unequal, which produceth twenty four : which general varieties may be further multiplied by their several degrees.

From all which we may come to know, what the Communities of Vegetables are, as belonging to all ; what their Distinctions to such a kind ; their Properties, to such a Species ; and their Peculiarities to such particular ones. And as in Metaphysical or other contemplative matters, when we have a distinct knowledge of the communities and differences of things, we may then be able to give their true Definitions : so may we be able possibly hereto do likewise ; not only to know that every Plant inwardly differs from another, but also wherein ; so as not more surely to define by the outward figure, than by the inward structure, what that is, or those things are, whereby any Plant or sort of Plants may be distinguished from all others. And having obtained a knowledge of the Communities and Differences amongst the parts of Vegetables, it may conduct us through a Series of more-facile and probable Conclusions of the ways of their causality, as to the Communities and Differences of Vegetation. And thus much for the second general Mean. Having

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Having thus far examined the organical and containing parts of Vegetables; it will be requisite more designedly to observe those also which are fluid, or any others contained in them: and that for our better understanding both of the Nature of Vegetation, and of the said contained parts. And to make inquiry, first of their kinds, as Spirits; both such as agree in general in being vinous, and those that are special to particular Plants. Airs and Vapours; for the existence whereof in all Vegetables there are certain Arguments. And for the difference of their natures, as they are existent in several parts, there are probable ones. *Lymphas* or clear Saps; Milks, Oyls, Gums, Sugars, Salts, or other concrete and fixed parts. Where by Salts I mean not such as are separated by Calcination, but are distinctly existent in Plants in their natural estate, and in some of them, as in the Roots of Iris, are discoverable, even without the help of a Microscope. To which may be added such Mucilages, which though not so properly contained within the parts, yet are found lying over them; as over the first Spring-leaves of all kinds of Docks, betwixt the Leaves and the Veil wherein they are involved.

Of all these should be observed, first their

Recepta-

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Receptacles, some of them being proper to one, others common to two or more of them: since it is certain, that some of them do transmigrate from one into another Receptacle, or that the same Receptacle is filled with bodies of a quite different nature, at the different seasons of the year, and ages of the Vegetable. And it is also very probable, that two of some of them may sometimes be contained in one Receptacle at the same time; as in Animals, the *Lympha* in the *D. Thoracicus*, and that and the Chyle in the sanguineous Vessels.

Then their Motions; both natural, and such as may be effected by Art: and those either by descent or ascent. And in ascending, through what different Chânels or parts of the Trunk; since it is certain, that there is a variety both in respect of the season and of Vegetables. Where it will fall in to observe the Tapping of Trees: As also their Bleeding: to what Trees it is proper to bleed: in those to which it is, with what difference of celerity: and when their peculiar season: for none will bleed at all times; neither will all bleed at the same. And then their collateral motion, together with the mode of their transition from one organical part to another.

Next their Quantities, either of one; as the

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the comparison is made betwixt several Plants, or betwixt the parts of the same: So the true Seed of all Plants containeth more Oyl in proportion than any of the rest. Or else of divers as coexistent and bearing such a proportion one to another in the same part: of most of which it may be known by their respective Receptacles. Yet the computation must not be made from the number of the said Receptacles simply, but as that is in conjunction with their capacity, and as their capacity is proportioned to their surrounding sides; the sides of those of the least capacity being usually as thick as those of the greatest: so that suppose ten lesser, to lye within the compass of one greater; the content of these altogether would scarce be equal to half the content of that one.

Also their Consistence; *scil.* of so many of them as are discriminable by touch; in being soft or hard, thin or thick, mucilaginous, gummous, glutinous, friable, &c. And these in their several degrees, in which there is a variety, as in the Milks of some Plants, which are more dilute than that of others; in their Lympha's or clear Saps, that of most being thin, of Cumfry and some others mucilaginous. And by this to be compared in the same manner as by their Quantity. Likewise

Likewise their Colours, Smells, and Tastes : The general and particular kinds of all which should be noted. And to what contained parts, and in what variety, they appertain. So the Milks of some are paler, as in Burdock; of others whiter, as in Scorzera; Citrine, in Angelica; Yellow, in Lovage. In some Plants odorous, as in Umbelliferous; in others not, as in Cichoraceous: and in most bitter, but with many diversities. And most Mucilages have little either Colour, Taste, or Smell, and the like. Here also the same Qualities are to be inquired into, as in general speaking they are said to be belonging to a Vegetable: since it is more than probable, that all Colours (excepting white, which is sometimes common both to containing and contained parts) all Odours and Tastes which are more immediately, and without a resolution of their essential Principles, perceptible in a Vegetable; are not ascribable to the organical or containing parts, but only to those contained in them; as from divers reasons hereafter may appear.

And first their Colours; where, with respect to several Plants and parts, they are more changeable, as red in Flowers; or constant, as green in Leaves. Which, with respect to several ages of one part, are more

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more fading, as green in Fruits; or durable, as yellow in Flowers. In what parts more single, as always in the Seed; or more compounded, as in the Flower; and in what Plants more especially, as in Pancy. Which proper to Plants that have such a taste or smell, as both in white Flowers are usually less strong. To Plants that flower in such a season, as a yellow Flower, I think chiefly to Spring-plants. And to Plants that are natural to such a Soil or Seat, as to Water-plants more usually a white Flower. What, amongst all Colours, more common to Plants, as green; or more rare, as black. And what all these varieties of Colours are upon Cultivation, but chiefly in their natural Soil. To observe also with their superficial Colours, those within; so the Roots of Docks are yellow, of Bistort red, of Avena purple, but of most white. Where the inward and superficial Colours agree, as in the Leaves; or vary, as in the other parts frequently. And in what-manner they are situated; some universally spreading, others running only along with the Vessels, as in the Leaves of red Dock, and the Flowers of Wood-Sorrel.

Next their Odours; what may be their principal Seat; whether one or divers seats in the same Plant. What the chief matter

out

out of which they are continually bred. What similitude betwixt the smells of divers Vegetables, as betwixt Baume and a Limon, the green Leaves of Meadow-sweet and the green Pills of Walnuts. Or betwixt those of Plants and Animals, as the smell of green and well-grown Carduus is like to that rank scent *ab axillis nonnullorum Spiranti*. Which have a more sensible smell, as most have; and which have less, as Corn. Where the green Leaf is the most fragrant part, as in Musk-Cranesbill; where the Flower, as in Roses; the Root, as in sweet Calamus. Where all the parts have some odour, where some, or one only; as in Scurvy-grass only the flowers; and in Arum the Pestil only, for neither the Leaf nor Root hath any smell, but this is strong enough, not much unlike to humane excrements.

But especially their Tastes, which it much importeth us more precisely to distinguish; first by their general kinds; for the number even of these may be computed greater than usually it is. I remember not that Heat and Acritude, with respect to Taste, are distinguished; yet Arum Root is very pungent without any proper heat, and Cloves are very hot without any proper pungency. So the white Roots of Yarrow have a Taste hardly any other way perceptible, than by causing

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causing a gentle glowing and continuing warmth upon the tongue. Also their resemblencies one to another; as that of Zeadoary, and of the lesser Cardamoms is somewhat like to Camphire. Likewise their degrees; in which there is a great latitude, and may be extended from one to ten, or with easie distinction from one to five; so the Root of Sorrel is bitter in the first, of Dock in the second, of Dog-Rose in the third, of Dandelyon in the fourth, of Gentian in the fifth: observing them not only as they vary in several kinds, but the several Species of one, as in Cichory, Hawkweed, Dandelyon. And then their Compositions; for Tastes are as truly conjunct in one part, as Colours: by which the latitude is still greater; in that all kinds of Tastes, in all their degrees, and in differing numbers may be variously compounded together: for the most part two, as in the Leaves of Sharp-pointed Dock, astringent and sowre; in Sorrel Roots astringent and bitter; and in Aloes bitter and sweet, the one in the fifth, the other in the first degree, as upon an unprejudiced tryal may be perceived: and yet more evidently in the Gall of any Land-Animal. Sometimes three, as in Agrimony bitter, rough, and sowrish; and in Agarick bitter, rough, and

and sweet. And sometimes perhaps more: the sensible distinctions of all which may lyc almost as wide as of Plants themselves. Wherefore although it were great rashness to take away the distinctions of Hot, Cold, Moist, Dry, Thin, Gross, and other Qualities, in their several degrees, which the Ancients have affixed to particular Plants; yet since they have done it to many of them with much uncertainty, and that withal they are more properly the effects and operations of Plants than their qualities; practical observation may therefore approve it useful, to add these sensible ones of various Tastes, precisely distinguishing their Conjugations and Degrees. Lastly, their several varieties, and mutations with respect to the subject wherein they reside, should also be noted. As, of all Tastes found in Plants, bitter and sowre are most common; sweet and salt most rare. How they vary with the age of the Plant or part, as the Roots of Radishes, growing up to seed, lose their strength; so most Fruits are first sowre, then sweet. What proper to the several parts of any one Plant; so the Leaves of Wormwood are extraordinary bitter, the Root scarcely so at all, of an hot, but quite different taste. What more common or rare to any part; so no Root, that

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that I ever tasted, is sowre. And how they alternate in several Plants; as the Root of Stock Gillow-flower is biting, not the Leaves; on the contrary, the Leaves of the smaller Arsmart are biting, but not the Root, and the like. To which we may add the difference of time wherein the tastes of Plants are perceived; as those of Arum and Rape-Crowfoot are both biting; but that of the first as it is slowly perceived, so it continues long; that of the other quickly comes and quickly goes.

Amongst the other adjuncts of the contained parts, though not of these only, the Faculties of Vegetables are to be reputed: for so the Resin of Jalap, which is purgative, is as truly contained in the organical parts of that Root, as blood is in Veins. It will be requisite therefore to make particular observation of these also. And first, what Faculties chiefly may reside in Vegetables above others: so there is none of known use in Salivation, except by holding in the mouth: although we may ask, why some amongst them may not (being taken inwardly) have a power to evacuate by this, as well as other violent ways? Where more universally spread over all the parts of a Vegetable, as in Asarum. Where belonging chiefly or wholly to any particular parts

parts or part ; as chiefly to the Root of Rhubarb ; and only to the true and proper seed of *Barbado* Nuts. Whether such faculties may be proper to such parts especially. What conjunction they may have with tastes, or other qualities ; so such as are purging and vomitory, though some of them have a strong taste, yet the greater part, and of those many of the stronger sort, have no taste, or not much ; as Senna, Jalap, Scammony, Hellebore, Asarum, and others. So also those that are more sensibly tasted, are, I think for the most part, more or less bitter ; either simply, as Colocynthis ; or bitter and astringent, as Rhubarb ; or bitter and sweet, as Aloe ; or bitter, astringent, and sweet, as Agarick. Few are hot, as Iris. Or simply sweet, as Manna. And though some may be subacid that are mollifying or lenitive, yet no proper Purge or Vomit is sower. How likewise their faculties and qualities may vary their degrees either differently or together ; so Aloe and Colocynthis are both bitter in the highest degree ; yet Aloe, which is also sweet, purgeth more moderately ; Colocynthis, which is only bitter, most violently. How far the faculties of Vegetables, as well as their qualities, may be compounded, where, and which chiefly ; as

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astringive and purgative in Rhabarb. Where this Question may be put, Whether divers other and yet more extreme faculties, as well as these of astringive and purgative, may not somewhere or other be also found, or made, to meet: whereby the same Plant, or preparation of it, may be most potent, and yet most innocent; the malignity thereof exerting its power, and the virtue its sovereignty at the same time. And lastly, what affinity there may be betwixt them, as most Plants that are strong Purgatives, and especially Vomitories, I think are also Sternutatory, as white Hellebore, Jalap, Tobacco: and on the contrary, such as are Sternutatory, are some of the most proper and most potent Medicines for the Head, Brain, and *Genus Nervosum*, taken inwardly, and the like. And thus far a particular observation of the Qualities and Faculties of the Contents of Vegetables may proceed, as they are existent in their natural estate. From which, although some probable conjectures may be made of their material and formal Essences, and of the Causes of their determinate Varieties, or the Modes of Vegetation necessary thereunto: yet will our conceptions hereof be more facile, clear, and comprehensive, if by all other ways of observation they be likewise examined, accord-

according as Experiment may be applicable to any of them.

As by Contusion ; so some Plants give their smell not without rubbing, or not so well ; as the green Leaves of Stramonium, Scurvygrass, and many more : others lose it by rubbing, as the flowers of Violets, Carnations, Borage, &c. others yield it both ways, as Rosemary, &c. So some Apples mend their taste by scooping, and Pears by rowling, especially that called the Rowling Pear.

By Agitation ; which doth that sometimes by force, which Digestion doth by heat : so any cold Oyl and a Syrup being in a due manner agitated together, of two fluid bodies will become one consistent, as is known.

By Frigification ; how far the Juices of Vegetables, either without or within them, may be any of them, or some more than others, subject to Cold : and thereby to be deprived of their motion or natural consistence, or may suffer alteration in their Colour, Taste, or Smell.

By Infusion ; where I mean Infusion only in simple water ; and so to observe, which of them may be dissolved herein, and how far ; for some may be wholly, some but in part, others not at all ; or very little ; which is

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is proper to some Milks as well as Gums. So what different Colours, Smells, or Tastes they hereupon yield; which are found various, and in some very unexpected; as the green Leaves of Bawm being duly infused in plain water, without any other body added, tincture it with a pure and deep red, near that of Claret Wine, as I have often tried.

By Digestion with Fermentation; either of the entire Vegetables, or of the Juyces or other Contents; and these by themselves or with simple Water. And hereby to note what difference may be in the strength, celerity, or continuance of the Fermentation. Likewise how their Qualities may thereby be altered; as the smell of Violet-flowers, from a most excellent fragrancy, may by Digestion be reduced to an odious and abominable stink, like that of the black Mud of Gutters, as I have tryed more than once.

By Digestion with Calcification; so the colour of the Juyce of Limons from transparency (if that be a colour) may be turned to a perfect red. Whence it is that many are deceived in the preparation called the Tincture of Corals; supposing the Corals to give the Menstruum its colour; whereas the Menstruum will obtain it only

by Digestion without any Corals mixed with it.

By Decoction ; either of Vegetables themselves, or of their Liquors ; and to observe what alterations follow. So Turpentine boiled becometh friable ; Sugar bitter and of a brown red. Turneps lose their biting taste, Onions their picquancy ; yet neither of them convey those self same qualities to the water. The same may be observed in the Decoction of sweet Fennel-seeds, Aniseeds, and others, losing much of their tastes themselves, and yet conveying very little of them to the Liquors wherein they are boiled, the greater portion of their volatile parts, and their virtue and taste therewith, flying away : whereof therefore it is much better to make an Emulsion, than to decoct them, or to make an Emulsion from them with their own Decoction, especially if the Medicine be intended to be Carminative, as I have frequently observed. The Decoction should also be carried on throughout all degrees to that of an Extract ; by which the qualities thereof sometimes are much altered ; as in that of the green Leaves of Violets, which from a kind of yellow, deepens at last into a dark colour as black as pitch, and that without the least Empyreuma.

By

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By Distillations ; both with the cold Still, Alembick, Chappel, or open Furnace : and to note what Vegetables thus give their smell or taste , and in what degrees of strength either under or over their natural ones ; as Mint, Pennyroyal, and the like, which are Aromatick and hot, give their tastes perfect : but Wormwood, which is Aromatick and bitter, gives it but by halves, only as Aromatick , little as bitter. And Carduus, though also so exceeding bitter, yet not being Aromatick , scarce yieldeth any taste at all. Also what Vegetables yield Oyl most plentifully ; and what difference may be in those Oyls as to their colour, weight, or otherwise, as that of Cloves is sometimes red, of Cinnamon lympid, both ponderous. So to distill Juices, Gums, or other Contents with an hot fire, and to see what bodies they yield, and of what qualities ; as Turpentine is known to yield besides its Oyl a subacid Water, Vinegar an eager Spirit, as that part may be called, which Chymists are wont to call the Phlegm.

By Arefaction ; so Milks which are liquid and white in their natural estate, in standing grow gummous, yellow, and otherwise different, so doth that of Scorzonera ; and that of Fenil into a balsamical, but limpid

Oyl. So the Roots of Arum upon drying lose much of the strength of their taste; but the contrary may be noted of many other Roots, which upon drying increase it. Some being cut and laid by, change their natural colours into red, purple, yellow, green, or white; as Liquorish into white in some places, and Peony into red; and sometimes into two, as Patience, into yellow and red.

By Assation; thus Apples by roasting eat more sowre. The Root of Horse Radish toasted tasteth like a Turnep. Potatoes, Onions, and many other Roots and parts have their tastes either altered or refracted; which chiefly and in what manner should be observed. There is one alteration as remarkable as commonly known, and is that which followeth upon roasting or baking in one kind of the *Waldensian* Pears, which for a Walden we corruptly call a Warden.

By Ustion; wherein some Vegetables lose their smell, as Roses; others keep it, as Rosemary; and others mend it, as Lignum Aloes. To note not only the alteration of their qualities, but what they yield; as Turpentine, which in Distillation yieldeth Oyl and Water both lymphid, upon Ustion sheweth nothing but a black Soot. So Benzone

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Benzonie by Distillation Oyl, by Ustion white Flowers, as is known.

By Calcination ; and here to observe wherein the *Caput Mortuum* of one may differ from or agree in nature with that of another ; and also to compare these with those of Animal bodies. As also in their quantities. And to compare them with what they yield by Distillation and Ustion as to both. Thus far they have been tryed simply or by themselves. They should also be examined.

By Composition ; not only with Water, as in simple Infusions, &c. but with any other bodies which may have a power of acting upon them, or upon which these may have a power to act. And so to make Infusions, Destillations, Decoctions, Digestions in divers kinds of Liquors, as Vinegar, Urine, Spirit of H. H. Wine, Blood, Milk, or others. So in Infusions some red colours are heightened by acids, blews turned purple. So fetid Spirits may doubtless be rendered much more grateful by being rectified once or twice with fresh Aromatics. To observe also what follows upon mixing the Liquors or other parts of Plants together ; as Oyl of Turpentine by Digestion with a Lixivial Salt extracteth thence a red Tincture. Or with Salts, Earths, Metals, or any other bodies, as the Juyce of the green
D 4
Leaves

Leaves of Rose, Raspberry, Primrose, and divers other Plants (I think principally such as are astringent) expressed upon Steel, as it drieth, becometh of a purple colour.

Lastly, by Compounding the Experiment it self, or joyning two or more of them upon the same matter : as Fermentation and Destillation, as is used for some Waters. Infusion and Fermentation, as in making of Beer. Fermentation and Coction, or rather Assaftion, as in making of Bread. Arefaction and Destillation, as may be tryed upon some Herbs, and with what difference from what may be noted upon their being distilled moist.

Having proceeded thus far by all the above particular ways of observation ; a comparative prospect must be taken of them : by which at last the Communities and Differences of the Contents of Vegetables may be discerned ; the manner of their Causation and Original partly be judged of ; and wherein it is that the Essence of their several Natures and Qualities doth consist, in some measure comprehended. And consequently both from the knowledge of their particular Natures, and the Analogy found betwixt them, we may be able better to conjecture and try what any of them are or may be good for. For certainly, we shall then

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then know more readily to apply things unto, and more fitly to prepare them for their proper uses, when we first know what they are. Notwithstanding, since the faculties of Plants do often lie more reclusè; it is best therefore not wholly to acquiesce in such Conjectures as their tastes or other properties may suggest; but to subjoin Experiment. In making which, and in passing a Judgment thereon, many cautions, both in respect of the Plant whereof, and the subject whereupon it is made, are requisite to be attended. Which yet, in regard they result not so directly from the matter at present in hand, I shall not therefore here insist upon. And thus much for the third general Mean.

Together with the Contents of the Organical parts of Vegetables, it will be requisite to examine their Principles also, or the Bodies which are not so properly contained in the said Organical parts, as immediately concurrent and essential to their Being. And of these we are to observe, first their Number; whether well reducible to five, six, seven, or more, or fewer: and the special differences observable under any one general; since there are many bodies of very different natures confounded under one name. Next their Conjugation; which they

they are that either under or over those observable in animal or other Bodies, are here joyned together in a Vegetable; How far common to the Organical parts of divers Vegetables; or to the several Organical parts of one; or how far different in them. Likewise their Proportions; which stand in the greatest, which in the least, or in the meaner quantities, and in what degrees; both in divers Vegetables, and in the several organical parts of one. And then the Concentration and Union of them altogether; as to the degrees of their closeness or laxity; or the manner of their Implication and Coherency; or as to their Location, one being more central, another more exposed and rampant over the rest; or otherwise different. To examine these Principles by their Colour, Taste, Smell, Consistence, Fixedness, Volatily, Weight, Figures, or other Accidents. And to these purposes, to go through the fore-mentioned ways of Experiment, as Ustion, Calcination, Destillation, &c. as any of them may appear applicable hereunto. And to make Experiment not only upon the several organical parts distinctly, but also upon the Principles themselves whereinto they are resolved, as by mixing them with one another, or with other bodies, or otherwise. I know it will be

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be difficult to make obſervations of this kind upon the organical parts of Vegetables ſeverally. Yet I have thought of ſome ways whereby true and undeceivable ones may be made upon ſome of them; and probably on the reſt alſo: which yet, in regard I have not made much trial of them, I ſhall not now mention.

The proſecution of what is here propounded will be requiſite, to a fuller and clearer view, of the Modes of Vegetation, of the ſenſible Natures of Vegetables, and of their more recluſe Faculties and Powers. Firſt, of the Modes of Vegetation. For ſuppoſe we were ſpeaking of a Root; from a due conſideration of the properties of any part or parts thereof; 'tis true, that the real and genuine Cauſes may be rendred of divers other dependent properties as ſpoken generally of the whole Root. But it will be asked again; What may be the Cauſes of thoſe firſt and independent ones? Which if we will ſeek, we muſt do it by inquiring alſo, What are the Principles of thoſe parts? For it is neceſſary that the Principles whereof a Body doth conſiſt ſhould be, if not all of them the active, yet the capacitating Cauſes, or ſuch as are called *Cauſæ ſine qua non* of its becoming and being, in all reſpects both as to Subſtance and Accidents,

dents, what it is : otherwise, their existence in that body were altogether superfluous, since it might have been without them : which if so, it might then have been made of any other ; there being no necessity of putting any difference, if neither those whereof it is made are thought necessary to its being. Wherefore if we will allow a Body, and so the organical parts of a Vegetable to have Principles ; we must allow these Principles their necessary use, and that the shapes, or other properties of the said parts are as much dependent upon the Nature of these, as is the roundness of a drop of Ink upon the fluidity of water ingredient to it.

Again, the Principles of the organical parts being known, we may from thence obtain a further knowledge of the Natures and Causation or Original of their Contents ; since these are not only included in the said organical parts, but also created by them : and must needs be so, whether we will suppose the Principles of these Contents to be præexistent to their reception thereinto, or no. For if not præexistent, what can be clearer than that the said parts give them their existence ? And if præexistent, yet in regard they are distinguished, and such only of them admitted in such sort into an organical

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nical part from amongst others, as are apt to combine and mix together in such a form, and so to constitute such a Liquor; it is as clear, that the existence, if not of those principles, yet of that Liquor, is dependent on the said part.

And if by means of the said parts it is that their Contents become such and such peculiar Mixtures; it is hence also manifest, that by the same means they are of such distinct faculties and powers: Because the faculty or power of a Body lieth not in any of its principles apart, but is a resultance from them all, or from their being in such peculiar sort and manner united and combined together. So the principles of the purgative parts of a Root, as of Rhubarb, although we should suppose them to be existent in the surrounding Earth, yet we cannot say that that Earth, or the principles therein contained are purgative; but only such as by being combined together in such a peculiar way may become so. So the several parts of a Clock, although they are and must be all præexistent to it, and it is their form by which they are what they are themselves; yet is it the setting together of such kind of parts, and in such a kind of way only, that makes them a Clock. And since we see that the mixture of two Bodies of

of two different qualities, as of two colours, will produce a third colour differing from them both, as blue and red do a murrey; why should not two or more bodies of different natures also, be so combined together, as to produce a third nature? Or wherefore may not that be allowed to be performed by Nature, which by artificial compounding of Medicines or other Bodies is designed, and often times effected? I'll give but one instance; Water, Grease, and an Alcalizate Salt may be easily so ordered as to be invested with new qualities, nature, and powers; the Salt to lose its extreme fiery pungent taste; the Tallow its smell; and being before unfociable with water, to mingle therewith; neither Tallow, Salt, nor Water alone will fetch out a spot of Grease, but all united easily do it; the same three parts united are, in some cases, as in the Jaundies, an excellent-Medicine, any of which given alone may rather prove prejudicial than a Cure: and all this done only by duly boiling them together into one body, which we call Sope.

Whence again, if it be such an union and proportion of such a sort of principles which produceth such a faculty; and that we may by any means come to know what these are; we may possibly also attain to the

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the knowledge of such Rules as whereby any kind of Faculty may be made, as to compound such bodies which are neither purgative nor vomitory, so together as to be invested with these Faculties. And if to make them, then consequently to mend, exalt, strengthen, and ennoble them with greater ease and certainty. And thus much for the fourth general Mean.

Hitherto we have considered the Materials of a Vegetable only as ingredient to it : there yet remains a fifth story to be ascended, which is to consider these Materials also as they are derived from abroad : or as after they are received and naturalized, they may with others yet abroad have any kind of correspondence. And these are four in general, *scil* Earth, Water, Air, and Sun, all which in that they contribute so universally to Vegetation, and to whatsoever is contained in a Vegetable, it is therefore requisite, that of these likewise particular observation should be made.

And first of the Earth, and of all solid Receptacles of Plants. Where we are to consider their several kinds, as Mellow, Sandy, Clayie, Chalky, and others. Their Ingredients, as rank and mellow Earth with Sand, or with Clay, or Sand with Clay, or altogether, and in what proportions. The Principle

Principles whereinto any one of these Ingredients separated from the rest, and put to the Test of Distillation, Ustion, Calcination, or other, either alone, or by mixture with other bodies, may be resolved, And by their qualities, as Colour, Smell, Taste, &c. both Ingredients and Principles to be examined. To make tryal of the growth of Plants in all kinds of simple Soils; either Earthy or Mineral, as Clay, Marl, Oker, Fullers Earth, Bole Armeniac, Vitriol, Alum, &c. or Vegetable, as rotten Wood, Brans, Starch, or Flower, &c. or Animal, as Dungs, pounded Flesh, dried and powdered Blood, and the like; that it may appear how far any of these may contribute to the growth of a Plant, or to one above another.

Next of the Water, and of all liquid Receptacles. Where the several kinds of Water from Wells, Springs, Rain, and Rivers are by their qualities and faculties to be examined, as these and by these their Principles either in their natural state or upon digestion, or otherwise may be observable: since plain Water it self is undoubtedly compounded of several Principles; the simplicity thereof being argued, neither from its clearness and transparency, for a solution of Alum, though it containeth a considerable

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considerable quantity of Earth is yet very clear; nor from its seeming to have neither smell nor taste, for Water drinkers will tell you of the varieties of both in different Waters. Besides, if these qualities should be accounted rather phantasie than sense, the difference of Waters is yet more manifest from their different effects, observed by Cooks, Laundresses, Brewers, and others, that have occasion to use them: for not to mix with Sope without curdling, not to boil meat tender, or without colouring it red, and the like, are the vices of some Waters, not of others, which yet would seem in colour, taste, and smell to be the same. Tryal should also be made of the growth of Plants in all kind of liquid Receptacles, as common Water, Snow water, Sea water, Urine, Milk, Whey, Wine, Oyl, Ink, &c. Or any of these with a solution of Salt, Nitre, Sal prunellæ, Sope, or other body. And hereby to observe what follows either in the Liquor, or in the Plant it self: as if any fixed body being weighed before its dissolution in water, and if the Plant set herein groweth, the water being then evaporated, whether the quantity of that dissolved body continue the same, or is lessened. So, whether any Vegetable will become Opiate by growings.

a considerable time in a plain solution of Water-tincture of Opium, and the like. Which Experiments what event soever they have, yet at least for our further instruction in the Nature of Vegetation may be of use.

Next of Air; where it will be requisite to inquire, what sort of bodies may be herein contained: It being probable, from the variety of Meteors formed herein, and of Vapours and Exhalations continually advanced hereinto, that some or other of them may bear an Analogy to all volatile bodies, whether Animal, Vegetable, or Mineral. And to consider the peculiar nature of that body which is strictly called Air. As also to try what different effects a diversity of Air may have upon a Vegetable; as by setting a Plant or Seed either exceeding low, as at the bottom of a deep Well; or exceeding high, as on the top of a Steeple. Or else by exposing some Soil to the Air, which is assuredly free from any Seed, and so as no Seed can light upon it, and to observe whether the Air hath a power of producing a Vegetable therein, or not: and the like.

Lastly of the Sun; as to which it may be considered, what influence it may have upon the Plant it self, upon the Soil, or upon the

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the Air. Whether that influence is any thing else besides heat, or may differ from that of a fire otherwise than by being temperate and more equal. Although it will be found very difficult here to make any sincere Experiments. As for that of Collection of the Sun-beams by the help of Glasses in the form of a Magistery or of Flowers, and such like, I desire to suspend my thoughts of them till I see them. I will only say thus much at present, That I do not understand why the Sun should not have some influence upon bodies besides by heat, if it may be granted that the Moon hath, for which it should seem there are some good arguments.

We have thus far examined the Principles necessary to Vegetation; the Question may be put once more, In what manner are these Principles so adapted as to become capable of being assembled together in such a Number, Conjugation, Proportion, and Union, as to make a Vegetable Body? For the comprehension whereof, we must also know, what are the Principles of these Principles. Which although they lie in so great an abyss of obscurity, yet I think I have some reason to believe they are not altogether undiscoverable: How far they may be so, I am so far from determining,

mining, that I shall not now conjecture.

This is the Design, and these the Means I propound in order thereunto. To which I suppose they may all appear to be necessary. For what we obtain of Nature, we must not do it by commanding, but by courting of her. Those that woo her may possibly have her for their Wife; but she is not so common as to prostitute her self to the best behaved Wit, which only practiseth upon it self, and is not applied to Her. I mean, that where ever men will go beyond phantasie and imagination, depending upon the conduct of Divine Wisdom, they must labour, hope, and persevere. And as the Means propounded are all necessary, so they may in some measure prove effectual. How far I promise not; the way is long and dark: and as Travellers sometimes amongst Mountains, by gaining the top of one, are so far from their Journeys end, that they only come to see another lies before them: so the way of Nature is so impervious, and, as I may say, down hill and up hill, that how far soever we go, yet the surmounting of one difficulty, is wont still to give us the prospect of another. We may therefore believe our attainments will be imperfect after we have done all: but because we cannot attain to all, that therefore we

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we should endeavour after nothing, is an inference which looks so much awry from the practical sense of men, that it ought not to be answered. Nor with better reason may we go about determining what may be done. The greatest designs that any men undertake, are of the greatest uncertainty as to their success: which if they appear to be of good import, though we know not how far they are attainable, we are to propound the means, in the utmost use whereof only we can be able to judge: a War is not to be quitted for the hazards which attend it; nor the Councils of Princes broken up, because those that sit at them have not the Spirit of Prophecy, as well as of Wisdom. To conclude, Although but little should be effected, yet to design more can do us no harm: For although a man shall never be able to hit Stars by shooting at them, yet he shall come much nearer to them, than another that throws at Apples.



THE COMPARATIVE
ANATOMY
OF
ROOTS
PROSECUTED.

THE SECOND PART.

CHAP. I.

BEing to speak of Roots, it is requisite, for our better understanding of what follows, that some things, as to their Figures, Motions, and Ages, be premised. Roots are generally distinguished, as to their

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their Figures, in being more Entire, as is Liquorish; or parted, as St. Johns wort. Parted either at the bottom, as most Roots; or at the top; as Dandelyon and some others. Parted again, are either Ramified, as Cumfry; or Manifold, as Crowfoot: both are parted, but the former, by the subdivision of greater branches into lesser; these, when divers Roots have all their distinct original from one head. Some are straight, as a Radish; others crooked, as Bistort. Smooth, as Bugloss; or stringy all round about, as Columbine. Thick, as Rhubarb; slender, as the Vine. Long, as Fenil; short, as a Turnep: which are distinct from great and little, in that these are so called with respect to several Roots; those with respect to the several dimensions of one. Short are stubbed, as Iris tuberosa; or round, as Dracontium. Round are tuberous, as Rape Crowfoot; bulbous, as Onion. Where note, That all bulbous Roots are as it were Hermaphrodites, or Root and Trunk both together: for the strings only are absolutely Roots; the Bulb actually containing those parts, which springing up, make the Leaves or Body; and is as it were, a great Bud under ground. Roots, again, are plain or uneven: Plain are Cylindrical, as Eryngo; or Pyramidal, as Borage. Grow-

ing smaller downwards, as do most ; or greater, as Skirrets. Uneven are pitted, as Potato's, where the eyes of the future Trunks lie inward ; or knobbed, as Jerusalem Artichoke, where they stand out. These differences are also compounded : so some Roots are both entire and smooth, as Peony ; others entire, but stringy, as Clary. Some both plain and knobbed, as Filipendula, *Lilium non bulbosum*, and others. And amongst them all there are several degrees : all which, with other differences, by those that undertake the Descriptions of Plants, are accurately to be noted : and in Drawing these, and all the other parts, their Sizes withal should be adjusted by a Scale. But the differences above mentioned will serve for our present purpose.

The Motions of Roots are also divers. Sometimes level, as of Hops, and all such as properly creep : Sometimes perpendicular, as of a Parsnep : which is different from straightness, for some straight Roots are level. Both of them are either shallow, or deep : Some run level, and near the Turfe, as wild Anemony ; others lower, as Dog-grass : some strike down but a little way, as Stramonium ; others grow deep, as Horseradish : which is different from being long ; for many long Roots are level, as Hops. Some

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Some again descend, as Tulips and other bulbous Roots : which differs from growing downwards ; in that here the head of the Root is immoveable ; but in descending, the whole Root doth *locum mutare*, running deeper time after time into the Earth. Some also ascend sometimes, and in some part appearing above ground, as Turneps. These Motions are also compounded, both in respect of the several parts of the Root, and of several times. So the main Root of Primrose is level, the stringy are perpendicular. The Roots of most Seedlings grow downward and upward at the same time. Those of Bistort, Iris, and some others, grow in part both downward and upward at several times : whence it is that Bistort is crooked ; and that some parts of Iris Root appear oftentimes above the ground. And many are writhed or twisted without being moved out of their place ; which motion cannot be observed but only by the oblique process of the Vessels, which we shall presently describe.

The Motion of Descent hath as yet been observed of Bulbous Roots only. But it is common to many Roots besides, as those of Arum, Primrose, Ammi, Avens, Iris, and others. For of the Trunks of these and many other Plants it is observable, that gradually

gradually and continually descending below the surface of the ground, and hiding themselves therein, they are thus both in nature, place, and office changed into true Roots, which, by the continuance of the said motion in the Trunk, also descend. This is more especially demonstrated by some, as by the level and knobbed Roots of Wood-Sorrel, Primrose, &c. For the Leaves of these Plants rotting off successively, and their Trunk gradually descending into the Mould, each Basis of these Leaves is nourished with a more copious Sap, and so swelled into so many knobs. The notice of this motion here, leadeth to the discovery of the like in other Plants, where the Leaves fall off close by the surface of the Trunk, as in *Iris tuberosa*, where only the seats of the perished Leaves and the ends of their Vessels are obscurely visible.

The Cause of this Descent, so far as it is dependent on the inward conformation of the Root, I shall hereafter shew. But the immediate visible one, are the String-Roots which these kind of Trunks frequently put forth; which descending themselves directly into the ground, like so many Ropes, lug the Trunk after them. Hence the Tuberos Roots of *Iris*, upon the rotting or falling away of the String-Roots hanging at them,

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them, sometimes a little re-ascend. Hence also the shape of some Roots is inverted; for whereas most are parted downwards into several Legs, some are parted upwards into divers Necks, as Dandelion and others. For these sending forth at the top several Trunk-buds, the said Buds successively put forth new and cast their old Leaves, and continually also making their descent, are at length formed into so many Necks of three, four, five, or more inches long under ground.

Hence also we understand in what particular way some Roots become perennial. Some are wholly so, as those of Trees, Shrubs, and divers woody Plants. Others in part, or by a new Progenies of Roots, from the old head or body, in the room of those that die yearly, or after a certain time; as of *Lilium non bulbosum*, Jerusalem Artichoke, Potato, Dog-stones, Monkshood, little Celandine, and others: in which Plants, one or more of their Roots are firm, the other spongy and superannuated, and partly by the ravine of the Trunk and other younger Roots reduced to a consumption and death. With these Tulips and other Bulbous Roots consort: for the several Rindes and Shells, whereof chiefly the Bulb consists, successively perish and shrink up into

into so many thin and dry skins: betwixt which, and in their centre, other Leaves and Shells being successively formed, the Bulb is thus perpetuated. In the same manner the String-Roots also succeed one another annually. So that at the end of divers years, although it be still looked upon as the same individual Root, yet is it in truth another as to every particle thereof. Lastly, many other Roots are perpetuated by the aforesaid descent of the Trunk, out of which it is still annually repaired, as by the gradual perishing of its lower parts it is diminished; as the tuberous Roots of Arum, Iris, Strawberry, Avena, &c. the extreme and elder parts whereof first fade, and by degrees rot off. Whence also we see the reason of the rugged and blunt extremities of these and some other Roots, as of that Plant superstitiously called Devils-bit; which is not so originally, but part thereof rotting off, the living remainder becometh stumped or seemeth bitten. Thus far of the general Shapes, Motions, and Ages of Roots.

CHAP.

CHAP. II.

INext proceed to the several Parts where-
of a Root is compounded. The outer
part of all is the skin ; which is common to
all Roots. 'Tis diversly coloured, whiter
in Skirrets, yellow in Dock, red in Potato,
brown in Lovage, black in Bugloss. Its
surface sometimes smooth, as in Horradish ;
rough , as in Scorzonera. 'Tis of various
size ; very thin in Parsnep, somewhat thick
in Bugloss, very thick in Iris. Sometimes
it is opacous, as in Thistle ; and sometimes
transparent , as in Madder. Every Root
hath successively two kind of skins : the one
coetaneous with the other parts ; and hath
its original from that which involveth the
parts of the Seed it self. The other post-
nate, succeeding in the room of the former
as the Root ageth ; and is originated from
the Bark.

This skin is usually, if not always, com-
pounded of two kinds of bodies : which
also is probable of the coetaneous. The
one parenchymous, and frequently constru-
cted of exceeding little Cells or Bubles ;
which in some Roots, as of Asparagus, cut
traverse, and viewed through a Microscope
are plainly visible. See the Figure. These
Bubles

Bubbles are of different sizes, in Bugloss larger, in Asparagus less; and sometimes they coincide and disappear. But in these and all other Roots, even where these Bubbles appear not, the Parenchyma of the skin is of the same substantial nature with that other more vivid and bulky one of the Bark: as is manifest from its being thence originated; and alike conformed, as shall be seen; and not only adjacent to it, as a Glove is to the Hand; but continuous therewith, as the parts of a piece of flesh are one with another.

Of this parenchymous body the skin consists chiefly, but not wholly; there being many tubulary Vessels mixed therewith: which though hardly by the Microscope, yet otherwise is demonstrable. For in tearing the skin, you shall do it more easily by the length than breadth; because by the first way, the continuity only of the Parenchyma is dissolved; but by the latter, both of this and of the Vessels, these being posited by the length of the Root: So that as by the smallness of the Bubbles of the Parenchyma, the skin is dense; so by these Vessels is it tough. Again, if you cut a Root traverse, and let it lie by for some time, all the parts, where there are no Vessels, shrink below the surface of the cut-end; but where-

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where-ever these are posited, there is no shrinking; which oftentimes evidently appears also in the skin: because the said vessels, though, as the Bubbles, they may coincide, yet they cannot visibly shorten or shrink up in length; no more than a Straw, whose sides may yet be easily crushed together. Further, the Root being cut traverse, if near the cut-end you very gently press the side of the Root with the edge of your nail, the sap will thereupon arise sometimes from the skin; in the same manner, as from any other part of the Root where the like Vessels are posited. And although the sap may likewise be expressed from the pith, and other parts where sometimes there are none of these Vessels; yet not without a solution of their continuity; which heretodoth not follow, as appears from the disappearing of the sap, together with the intermission of the pressure, the said Vessels then dilating themselves by a motion of restitution, and so sucking up the sap again. Hereunto may be added the testimony of sight; the very Vessels themselves, in many Roots, coming under an apparent view, and standing in the utmost surface of the Root all round about, as in that of Liquorish, Columbine, Scorzonera, and others. [*see the Figure of Scorzonera Root.*] Which Experiments

riments I have here once for all more particularly set down, because I shall have occasion hereafter to refer to them.

CHAP. III.

NExt within the skin lieth the Bark. 'Tis sometimes yellow, as in Dock; red, in Bistort; but usually, and in seedling Roots I think always, white. It is derived from the seed it self; being but the extension or prolongation of part of one of those bodies therein originally existent, and which I have elsewhere called the Radicle. It is variously sized; sometimes very thin, as in Jerusalem Artichoke, Goats-beard, and most Trees; where it also retains the name of a Bark or Rinde. Sometimes 'tis more thick, and maketh up the far greatest part of the Root, as in the String-Roots of Asparagus, Dandelion, and others. The thinnest and the thickest are all analogous, and obtain the same general uses. The degrees of its size amongst all Roots may be well reckoned about twenty, and seen in the following examples, *ſc.* Beet, Dropwort, Jerusalem Artichoke, Orpine, Valerian, Goats-beard, Nettle, Brownwort, Columbine,

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Columbine, Celandine, Asparagus, Horseradish, Peony, Bryony, Eryngo, Borage, Lovage, Dandelion, Parsnep, Carrot: in which the Bark is considered absolutely, and not in comparison with the other parts. See the Figures.

It is compounded of two Bodies. The one parenchymous; continuous throughout; yet somewhat pliable without a solution of its continuity. Exceeding porous; as appeareth from its so much shrinking up in drying. The pores hereof are extended much alike both by the length and breadth of the Root; therefore it shrinketh up by both those dimensions more equally. And they are very dilative; as is also manifest from its restorableness to its former bulk again, upon its infusion in water: that is to say, it is a most curious and exquisitely fine wrought Sponge. Thus much the eye and reason may discover.

The Microscope confirms the truth hereof, and more precisely shews, That these pores are all, in a manner, spherical; and this part nothing else but an infinite Mass of little Cells or fixed Bubbles. The sides of none of them are visibly pervious from one into another, but each is bounded without it self: So that the Parenchyma of the Bark, is much the same thing, as to conformation, which

which the froth of Beer or Eggs is as a fluid, or a piece of fine Manchet as a fixed body. The sides also of these Bubbles are as transparent as those of Water. [*See any of the Microscopical Figures.*]

But their size is usually much smaller; and their posture more regular. In all Roots they are so small, as scarcely without the Microscope to be discerned: yet are they of different sizes both in the same and in divers Roots; the varieties whereof amongst all Roots may be reduced to about ten or twelve, some of those in Dandelion being of the smallest, and in Bugloss of the greatest. [*See the Microscopical Figures.*] They are posited for the most part at equal height; and piled even one over another: so that oftentimes they visibly run in ranks or trains both by the length and breadth of the Root, as in the Root of Bugloss or Dandelion split through the middle may be seen. Although they are usually spherical, yet sometimes and in some places they are more oblong, as in the outward part of the Bark of Bugloss. [*See the Microscopical Figure.*] These Bubbles are sometimes best seen, after the Root, being cut transverse, hath layn by a while to dry.

They are the Receptacles of Liquor; which is ever of a limpid colour; and I think

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think always more thin. They are in all Seed-Roots filled herewith ; and usually in those also which are well grown, as of Brage, Radish, &c.

This parenchymous part is, in many Roots, of one uniform contexture ; as in Asparagus, Hors-Radish, Peony, Potato, and others. In many others it is as it were of a diversified woof ; the Bubbles being, though regular, yet either in shape, size, or situation different in some parts hereof from what they are in other intermediate ones. For these parts are like so many white Rays streaming, by the diameter of the Root, from the inward edge toward the circumference of the Bark ; as in Lovage, Melilot, Parsnep, &c. They are, though not in direct lines, continued also by the length of the Root ; so that they are as it were so many Membranes by which the other parts of the Bark are distinguished. Compare the Figures.

The continuation of these diametral Rays or Portions is divers : sometimes but half through the Bark, or somewhat more or less, as in Melilot. Sometimes, and usually running quite through to the very skin, as in Parsley : wherewith the skin seems to have a closer communion, and in this and the like Roots ; to be originated especially therefrom.

from. They usually stand at an equal distance in the same Root; but with respect to divers, their distance varies; so less in Parsnep, greater in Angelica. They are commonly rectilinear, as in Lovage; but sometimes winding to and fro, as in Carrot, Burnet. See the Figures.

They are not always of one size: in a Carrot exceeding slender, and scarcely discernable; in others thicker, as in the three greater ones of Melilot, common Chervil. Both by their distance and size they are also less or more numerous, some only as they are nearer, some as smaller, others as both. Sometimes they are of the same thickness through the Bark from edge to edge, as in Lovage. See the Figure. And sometimes are considerably spread or dilated towards the skin, wherewith they are joyned, and whereinto they more visibly run, as in Parsley. See the Root it self. The Bubbles of these diametral portions are sometimes greater than those of the other parenchymous parts, as in Parsley; and I think, sometimes less. Yet as there so here variously sized; to about six or eight degrees; and those of Parsley about the third, fourth, and fifth. Their figure is sometimes more oblong; and their direction or respect more towards the centre of the Root.

As

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As the other parenchymous parts of the Bark are the Receptacles of Liquor, so these (where they are) of Air. This is argued from their being more white, and not transparent, as such Roots and parts use to be, which are more copiously and equally filled up with liquor: as the pith of Elder, which in the old stalks is white, was once, and by being well soaked, will become again transparent. And from their being more dry and void of liquor; whereupon their bubbles, which cannot be vacuities, must be filled with more or less Air, mixed with the sap or the vaporous parts thereof. This is more observable in those diametral Portions which terminate upon and run into the skin.

The Bark is not only of a divers woof, but, as is said, of a compounded substance; there being a certain number of *Succiferous Vessels*, fewer or more, in some place or other, mixed with the parenchymous part above described; and some way or other are demonstrable in all Roots: as by the toughness of the Bark in being broken by the breadth: by the visible continuation of the said Vessels through the length of the bark in the resemblance of small threads: and by the rising up of the sap in the transverse cut of the Root, in such places of the

Bark,

F 3

As

Bark, where these threads terminate : as the existence of those of the Skin was proved *Chap. 2.*

These tubular Threads run not through the bark in direct lines, but are frequently braced together in the form of Net-work ; the parenchymous parts every where filling up the spaces betwixt the braced threads ; as in Burnet, Scorzonera, &c. the bark being paired or striped off is apparent. See the Figures. They seem at first, where they are braced, to be inosculated, so as to be pervious one into another : but a more accurate view, especially assisted by a Microscope, discovers the contrary. Neither are they wound any way one about another, as threads are in a Rope : nor implicated, as in raveled Yarn or the knots of a Net : but only contiguous or simply tangent, as the several Cords in the Braces of a Drum : being thus joyned together by the parenchymous parts, as in speaking of the Pith will be understood how. Yet do not always the same threads belong and keep entire to one brace ; but are frequently parted into lesser threads transposed from brace to brace. Nor do they always, in whole or in part, presently after their contingence, mutually fall off again ; but oftentimes run along collaterally joyned together for some space, as in
Jerusalem

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Jerusalem Artichoke. These braces are of various number in divers Roots; more frequent in Jerusalem Artichoke, less in Scorzonera, more rare in Cumfry. The threads likewise are variously divaricated; sometimes more where the braces are frequent, as in Jerusalem Artichoke; and sometimes less where the braces are rare, as in Scorzonera, Dandelyon: And in all Roots more frequent towards the inner Verge of the bark. See the Figures.

By what is said it is partly implied, That these threads are not single Vessels; but a cluster of them, twenty, thirty, or more or fewer of them together. Yet as the threads are not in the braces; so neither are the Vessels, in the threads, inosculated. Nor yet twisted; but only stand collateral together; as the several twires of the Silkworm do in sieve-silk. Neither are these Vessels Pyramidal, so far as the Glafs will discover, or from probable reason may be conjectured. Nor ramified, so as to be successively propagated one from another, after the manner of Veins: but Cylindrical, and distinctly continued throughout the length of the Root, as the several fibres in a Tendon or Nerve.

These Vessels are of divers kinds in divers Roots: of the different natures where-

of, although there may be other ways whereby to judge; yet so far as by inspection, we may do it chiefly by the diversity of those liquors which they severally contain. Sometimes they yield a Lympha; and that thin, as they do in a Parsnep; especially those that make a Ring at the inward extremity of the bark. See the Root it self. That this clear sap ascendeth only from these Vessels, is certain; because no liquor will do so from any parenchymous-part, as *Chap. 2.* hath been said. And because it is of a different nature from the sap contained in the bubbles of the Parenchyma; although of the same colour, yet sensibly more sweet.

Sometimes they yield a thick and mucilaginous Lympha, as in Cumfry, as appeareth by its tenacity. From the mucilaginous Content of these Vessels it is, I suppose, that the sap contained in the bubbles is rendered of the like nature, so far as it approaches hereto; which sometimes is more, as in Marsh-mallow; and sometimes but little, as in Borage: For in pressing out the liquor of this Plant, and then heating it over an indifferent fire; the far greater part hereof remaineth thin; only some certain strings and little bits of a gellied substance are mixed herewith; which I suppose, were originally

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originally the proper liquor of these Lymphæducts.

Ofentimes these succiferous Vessels yield a milky or white sap; and sometimes yellow, and of other colours; as in Sonchus, and most Cichoraceous Plants; in Angelica; and most Umbelliferous; in Burdock, and divers Thistles, to which that is 'akin: in Scorzonera, Common Bells, and many other Plants not commonly taken notice of to be milky. The milky saps of all which, although they differ in colour and other qualities, yet agree in being more oily; it being the mixture of the oily parts with some other limpid liquor, but of a different nature, which causeth that colour. In the same manner as common Oyl and a strong Liqumamen Tartari shaken in a Bottle together, presently mix into a white Liquor: and although they will for the greatest part separate again; yet some of their parts without any boiling, or so much as the least digestion with heat, by agitation only, or standing together for some time, incorporate in the form of a thin milky Sope, which will also dissolve in Water. I suppose therefore that it is the volatile Salt chiefly of these Plants, which being mixed with their Oyl, renders this Liquor of a white or other colour. Sometimes the Oyl will

will separate and discover it self: for if you cut a Fenil root traverse, after it hath layn some days out of the ground; the same Vessels, which in a fresh Root yields Milk, will now yield Oyl.

All Gums and Balsams are likewise to be reputed the proper Contents of these Vessels: for these and Milks are very near 'akin. So the Milk of Fenil, upon standing, turns to a clear Balsam; of Scorzonera, Dandelyon, and others to a Gum. And in the dried Root of Angelica, &c. being split, the Milk, according to the continuation of these Vessels, appeareth, as blood clodders in the Veins, condensed to an hard and shining Rosin. See the Roots themselves.

These succiferous Vessels are not only of divers kinds in divers Roots, but in the same. Whether in all, I doubt: but in some it is certain they are: For if you cut a Fenil root traverse, both milks and limpid sap will presently ascend, and upon accurate inspection appear thereupon distinctly. [*See both the Figure and the Root it self.*] Whether all Roots have Lymphæducts, it is also doubtful; but most probable that they have, more or fewer, standing for the most part in a Ring at the inner Verge of the Bark: the sap whereof may be so far off common

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common Nature in all Roots as to be clear and less oily.

The Quantity of these Vessels is very different : In Borage, Peony, Bistort but few ; in Asparagus fewer : in Parsnep, Celandine many ; in Fenil, Marsh-mallow many more : and betwixt these extremes there are many degrees , as by comparing the Roots of Horradish, Turnep, Briony, Skirrets, Parsley, Goats-beard , and as many more as you please, may be seen. See the Figures. There are two ways of judging of their number ; either as their extremities are visible upon the traverse cut of the bark ; or as the bark is diversly brittle or tough, being so from the various number of these Vessels therein, as *Chap. 2.* hath been said.

The quantity of the ascending Sap, is a doubtful argument, whether of the number or size of these Vessels. For it is common to most milky Roots, for the Milk to ascend more copiously : yet in some of them, the Vessels seem not to be, in proportion with the parenchymous part, so numerous as in some other Roots, where the ascending sap is less ; as by comparing the Lacteals of Dandelion and the Lymphæducts of Fenil together may appear : so that it should seem, that the bore of the lacteal Vessels is greater than that of the Lymphæducts.

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The Situation of these Vessels is various and elegant. Sometimes they are posited only at the inner edge of the bark, where they make a Ring, as in Asparagus. In which place and position they stand in most, if not in all, Roots, how variously soever otherwise they are posited. This Ring is either more entire, as in Eryngo, Brownwort, Valerian, &c. or it is a prick'd Ring, as in Butterbur. Sometimes they are chiefly posited in a Prick-ring towards the outward part of the bark, as in Peony: and some are prick'd all over the bark, as in Melilot. In others they stand not so much in pricks, as portions or Columns, as in Cumfry. In others again they all stand in more continued lines, either Rays or diametral, as in Borage; or Peripherial, as in Celandine. The Rays are not equally extended in all Roots: in Parsnep towards the circumference of the bark; in Bugloss about half way. In Borage, the rays are more continuous; in a Carrot, more prick'd. Here also the pricks stand in even lines; in Lovage they are divaricated. Of which, and those of some other Roots, it is also observable, that they are not all properly pricks, but most of them very little circles, which, after the Milk hath been frequently licked off, and ceaseth to ascend, are

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are visible. See the Figures. And note, that in observing all Milk-vessels, the Milk is to be taken off, not with the finger but the tongue, so often till it riseth no more, or but little. And some Roots may also be soaked in Water, whereby the position of the Milk-vessels will be visible by the darker colour of the bark where they stand.

The Rays sometimes run more parallel, and keep several, as in Monkshood; and sometimes towards the circumference of the bark they are occurrent, as in Eryngo: here in a termination more circular, and in Bryony angular, or in the form of a Glo-ry; as also in Horradish through a Microscope. The peripheral lines are in some more entire Circles, as in Dandelyon; in others made up of shorter Chords, as in Potato, Cumfry, and the smaller part of the Root of Monkshood. In some the pricks are so exceeding small, and stand so close, that, to the bare eye, they seem to be continuous Rings, which yet through the Microscope appear distinct, as in Marsh-mallow and Liquorish. See the Figures.

Sometimes Columns and Chords are compounded, as in Burnet; Pricks and Chords, in Potato; Rays and Rings, in Monkshood; where the Ring is single. In Fenil there is a double or treple order both of Rays and Rings,

Rings, the Lymphæducts standing in Rays and the Lacteals in Rings. And in Marsh-mallow the Vessels are so posited as to make both those kinds of lines. In Celandine they seem all, to the bare eye, to stand in numerous Rings lying even one within another. See the Figures. As also in Dandelion; in which yet, being viewed through a Microscope, there is an appearance of very many small Rays, which streaming from the inner Verge of the Bark, cross three or four of the smaller Rings, and there terminate. See the Microscopical Figure. Whence it should seem, that Lymphatick Rays and milky Rings are so far mixed together; only the Lympha being confounded with the Milk cannot be discerned. And where the milky Vessels are evacuated, or at such seasons wherein they are less full, divers milky Roots will yield a clear Liquor at the inner Verge of the Bark, where, at other times, they seem to yield only Milk. And this is the Description of the Bark.

CHAP. IV.

That Portion of the Root which standeth next within the Bark, is also compounded of two bodies, Parenchymous and Lignous. The Parenchymous is of the same substantial Nature with that of the Bark: and is originated from it; being not only adjacent to it, but all round about continuous therewith, even as that is with the skin; the Parenchyma of the Bark being distributed, from time to time, partly outward into the skin, and partly inward into this.

The position of the several parts hereof is different. For the most part they have a diametral continuation in several Portions, running betwixt as many more of the Lignous parts from the circumference towards the Centre of the Root. In the Roots of some Plants they are more observable, as in Cumfry; which leadeth to the notice of them in all others both of Plants and Trees. See the Figure. Sometimes part of this parenchymous Body is disposed into Rings, as in Fenil. The number and size of which Rings differ; in Fenil they are

are in some places broader, but fewer; in Beet they are narrower, but more. See the Figure. The diametral portions are in like manner much varied; in Cumfry, Celandine larger; in Beet, Buglofs, meander; in Borage, Parsnep more and lesser; and in most woody Roots, streaming betwixt the pith and the bark as so many small Rays. Their continuation is also different; in some Roots to the Centre, as in Columbine; in others not, as in Parsnep. See the Figures. And sometimes different in the same Root, as in the Vine. See the Microscopical Figure.

The Contexture of these parenchymous Portions is sometimes uniform, as in Buglofs, Peony; and sometimes also, as it is in the bark, different; in part more sappy and transparent, in part more white, dry, and airy, as in Carrot, Lovage, Scorzonera, and others; which yet cannot be observed without a wary view. See the Figures. But their general texture is the same being all made up of many small bubbles: which are of different sizes, like those of the bark; but for the most part smaller. Their shape likewise is usually round; but sometimes oblong and oval, as in Borage; or oblong and square, as in the Vine.

The Lignous part, if not always, yet usually,

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usually, is also compounded of two kinds of bodies, *scil.* Succiferous and Air-vessels. The Succiferous are, as far as discernable, of the same conformation and nature with those of the bark, and in the transverse cut of the Root, do oftentimes, as those, emit a Liquor. They are also Braced; and many of them run in distinct Threads or portions collaterally together. The Air-vessels I so call, because they contain no Liquor, but an airy Vapour. They are more or less visible in all Roots. They may be distinguished to the bare eye from its parenchymous parts by their whiter surface; and standing more prominent, while those shrink below the transverse level of the Root, upon drying. They are frequently conjugated divers of them together; sometimes fewer, and for the most part single, as in Asparagus; sometimes many, as in Horseradish. See the Microscopical Figures. And their Conjugations are also braced, as the threads of the Succiferous Vessels. But they are no where Inosculated: nor twisted one about another; but only tangent or collateral. Neither are they Ramified, the greater into less; but are all distinctly continued from one end of the Root to the other.

Their Braces, as those of the Succiferous,
G Vessels

Vessels, are also of various number; in Cumfry, Scorzonera more rare; in Borage more frequent; as by stripping off the bark of such Roots where it is easily separable, may be seen. See the Figure of Scorzonera. And they often vary in the same Root; so in Borage, Scorzonera, &c. they are more frequent in the Centre and next the bark than in the intermediate space, as by splitting those Roots down the middle doth appear. See the Figures. They also vary from those of the succiferous Vessels; those being usually more frequent, as in Jerusalem Artichoke, than these of the Aerial. See the Figures.

Betwixt these braced Air-vessels run the parenchymous parts above described, as they do betwixt the succiferous in the bark. See the Figures. An agreeable structure hereto may be observed in the parts of a Muscle; wherein some, more membranous and white, are posited and knit together in the form of Lozenges or close Network: others, more red, or soft, fill up all the interjacent spaces, and have a counter-process or continuation; the one by the breadth or thickness of the Muscle, the other by the length. The same structure is likewise visible in Tendons, but more diffusely

The

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The position of both these kinds of Vessels is various. The Succiferous are sometimes posited in diametral lines or portions, as in the Vine ; Sometimes oppositely to the Aerial, as in Beet ; each Ring herein being double, and made both of Sap and Air-vessels. In Nettle the Succiferous run cross the Aerial in several, five, six, seven, or more Rings. In Bryony the several Conjunctions of the Aerial are surrounded with the Succiferous. In Patience the Succiferous are disposed, besides Rays, into many small Rings of different sizes sprinkled up and down, and not having one common Centre : within divers whereof Aerial are included : especially within those which are drawn not into Rings, but as it were straggling Hedges. See the Figures.

That also of the Air-vessels is various and elegant. In *Anni*, *Lilium non bulbosum* they make a Ring. In these a prick'd Ring ; in Peony a Ring of Rays ; in Valerian a Ring of Pricks and Rays. In others they make not Rings, but longer Rays, extended either towards the Centre, as in *Scorzonera* ; or meeting in it, as in Columbine. In Beet they stand in several Rings, and every Ring made of Rays. In Cumfry the Rays and Rings are separate, those stand without, these next the Centre.

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In Celandine they are of a parallel, in Monkshood of a wedged form. In Borage the position of many of them is spiral. In Horse Radish, they stand more confused neither in Rings nor in Rays; yet their several Conjugations are radiated: with very many other differences. See the Figures.

The Quantity of these Vessels, as to the space they take up in the Root, is to be computed two ways, by their Number or Size. Their Number may, in some Roots, and in some measure, be judged of by the bare eye, having frequently a whiter surface than the other parts. As also their Size; the bore of these Vessels being greater than that of the Succiferous in all Roots; especially some. For if you take the Roots of Vine, Fenil, Dandelyon, Plum-tree, Elder, Willow, &c. and lay them by for some time to dry; and then having cut off a very thin slice of each transversely, if you hold up those slices before your eye, so as the sight may be trajected through the said Vessels, they hereby become visible, as notably different both in number and size.

But undeceitful and accurate observation of both their Number and Size must be made by the Microscope; and so they will appear to be much more various. In Bi-stort, Skirret, they are very few; in Beet very

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very many : betwixt which extremes there are all degrees ; as in Orpine, Monkshood, Scorzonera, great Celandine, Peony, Borage, Fenil, &c. may be seen. So their Size in some is extreme small, as in Strawberry, Bistort, Valerian ; in others very great, as in Asparagus, Bugloss, Vine. They are also of several sizes in the same Root ; but in some are less varied, as in *Lilium non bulbosum*, Asparagus, Bugloss ; in others more, as in Bryony, Lovage. Amongst all Roots they vary by about twenty degrees ; as by comparing the Roots of Vine, Thorn, Apple, Bryony, Lovage, Fenil, wild Carrot, Saxifrage, Parsley, Peony, Horehound, Cinquefoyl, Strawberry, &c. together, may be seen. See the Figures of so many of them as are drawn.

In some Roots they are small and few ; as in Jerusalem Artichoke ; in others small, but many, as in Horse-Radish : in Bugloss they are great, but few ; in Vine great and many. So that the proportion which those of a Vine, their number and size being taken together, bear to those of Jerusalem Artichoke, may be at least as fifty to one. See the Microscopical Figures. Of the smallest kinds, as those of Cinquefoyl, Jerusalem Artichoke, and the like, it is to be noted, that they are scarce ever visible in the

G 3 fresh

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fresh slices of these Roots, but after they have layn by a while, at laſt by a good Glaſs, clear light, and ſteddy view, are diſcernable.

In ſome Roots the greater of theſe Veſſels ſtand in or next the Centre, as in Taraxicum; in others next the circumference, as in Horſe-Radiſh. Sometimes each of them is from one end of the Root to the other, of a more equal ſize, or more Cylindrical, as in Maſh-mallow; but uſually they widen more or leſs from the top to the bottom of the Root, as in Thorn-Apple; about the top whereof they are for the moſt part but of the ſixth, ſeventh, and eighth magnitude, ſome of the fifth, but none of the third; but about the bottom they are moſt of the third and fifth: whence it is manifeſt. that ſome of them are, in the manner of Vcins, ſomewhat pyramidal: yet their ampliation proceedeth not towards, but from their Original, as in Nerves.

Of theſe Veſſels the learned *Malpighius* hath obſerved; *Componuntur* (ſaith he) *expoſitæ fiſtulæ Zonâ tenui & pellucidâ, velut argentei coloris laminâ, parum latâ; quæ, ſpiraliter locatæ, & extremis lateribus unitæ, Tubum, interius & exterius aliquantulum aſperum, efficit.*

To whoſe obſervation I further add,
That

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That the Spiral Zone, which he so calls, is not one absolutely entire piece ; but consisting of two or more round and perfect Fibres standing collaterally together : and according as fewer or more of these Fibres happen to break off, from their spiral location, together, the Zone is narrower or broader ; usually narrower in the Trunk, and broader in the Root.

Of these Fibres it is also observable, that they are not Inosculated side to side, but are knit or stitched together by other smaller ones ; those being as it were the Warp, and these the Woof of these Vessels. Yet I think the several Fibres are not interwoven just as in a Web ; but by a kind of wreath or stitch, as the several plates of a Mat. A clear and elegant sight of these fibres, and of their interweaving, by splitting a Vine root, or a piece of Oak, may, in the sides of their greater Air-vessels, be obtained ; having altogether the resemblance of close Needle-work.

The Spiration of the Fibres of these Vessels may be more easily observed in the Trunk than in the Root ; and better in younger Plants ; and not so well by cutting as splitting, or tearing off some small piece through which they run, their conformation being by this means not spoiled. Yet this

way

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way they are seen chiefly unresolved. But in the Leaves and tender Stalks of all such Plants as shew upon breaking a kind of Downe or Wool, they may be seen resolved and drawn out, and that sometimes even to the naked eye, an inch or two in length; this Wool being nothing else but a number of Fibres resolved from their spiral position in these Vessels, and drawn out in length, and so cluster'd together as so many Threads or little Ropes; appearing thus in most Vegetables, but especially in some, as Vines, Scabious, Squills, and others. See the Plants themselves. The process of their spiration is not, so far as I have observed, accidental, but constantly the same; *scil.* in the Root by South from West to East; but in the Trunk contrarily, by South from East to West.

The Content of these Vessels is, as hath already been intimated, more airy. The proof whereof is, that upon a transverse cut of the Root, the Sap never ascendeth there where these stand. Being also viewed through a Microscope, they are never observed to be filled with liquor. Besides, a Root cut and immersed in water, till it is in some part got into these Vessels, and then taken out and crushed; the other parts will yield liquor, but these only bubbles;

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bles ; which bubbles rise from some small quantity of Liquor mixed with the Air before contained in the said Vessels. To which other arguments will arise out of those things that follow. As also for this Content its not being a pure, but vaporous Air. Whether these Vessels may not, in some Vegetables, and at some times, contain Liquor, is doubtful. Thus far of the Lignous Part.

CHAP. V.

Within the Lignous Part lyeth the Pith. This part is not common to all Roots, for some have none, as Nicotian, Stramonium, and others. Yet many which have none or little throughout all their lower parts, have one fair enough about their tops, as Mallow, Borage, Dandelyon, and the like. See the Roots. And in many others there are Parenchymous parts, of the same substantial nature with the Pith, visible from the top to the bottom, as in Beet, Fenil, &c. See the Roots and Figures. The size of the Pith is varied by many degrees easily reckoned an hundred ; in Fenil, Dandelyon, Asparagus but small ; in

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in Horfradish, Valerian, Bistort great. See the Figures. The shape hereof in the lower parts of most Roots is pyramidal; but at the tops various, according to the different distribution of the Vessels, as in Carrot, Hyperbolical, in Parsley^o Oval; as appeareth in cutting the Roots length-ways. See the Figures.

The Pith, for the most part, especially in Trees, is a simple body: but sometimes it is, as the Bark, compounded, some certain number of Succiferous Vessels being mixed herewith; as in Jerusalem Artichoke, Horfradish, &c. upon a traverse cut, by a strict view, may be discerned. See the Figure. Their position is sometimes confused, as in Carrot; and sometimes regular, as in Parsley, appearing by the traverse cut in Rings, and in cutting by the length in Arches. See the Figure.

As all the other parts of the Root are originated from the Seed; so sometimes is the Pith it self. But sometimes it hath its more immediate derivation from the Bark. Hence it is, that many Roots which have no Pith in their lower parts, have one at their top, as Columbine, Lovage, &c. See the Roots. For the parenchymous parts of the Bark being by degrees distributed into diame-
tral Portions, running betwixt those of the
Lignous

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Lignous body, and at length meeting and uniting in the Centre, thus constitute the Pith. In the same manner, at the top of some Roots, the Pith is either made or augmented out of the Parenchymous Rings above described, these being gradually distributed to and embodied in the Centre; as in Fenil and some other Roots, their lower and upper parts compared together, may be seen.

From hence the Pith appears to be also of the same substantial nature with the Parenchyma of the Bark, and with the diametral Portions, and that they are all one body differing only in shape and place. As also from its being continuous with the diametral Portions, in like manner as these are with the said Parenchyma. And from its Contexture, which by a Microscope appeared to be the same in all; this being also made up of bubbles: which the learned Mr. Hooke first shewed me of the Pith in the Trunk of Elder. And I having before demonstrated that the Bark and diametral Portions were of one substantial nature with the Pith; (As also all the other Parenchymous parts of a Plant, in the Leaves, Fruit, &c. as I have elsewhere described them) I conjectured they were also of the self same Contexture; and accordingly, having

having viewed them through a good Glass, I found they were.

The Bubbles of the Pith are of very different sizes: seldom less than in the bark, as in Asparagus; usually much bigger, as in Horradish. They may be well reckoned to about fifteen or twenty degrees; those of Jerusalem Artichoke of the largest; of Valerian, Horradish, of the meaner; in Bistort, Peony of the smallest. See the Figures. Their position is rarely varied, as it is oftentimes in the bark, but more uniform, and in the transverse cut, equally respective to all parts of the Root: yet being piled evenly one over another, in the long cut they seem to run in direct trains by the Length of the Root. Their shape also is usually more circular; but sometimes somewhat angular in the larger kinds, as in Jerusalem Artichoke. See the Microscopical Figure.

Thus far the contexture of the Pith is well discoverable in the Root. In the Trunk farther and more easily. Yet since I am giving the Description hereof, I shall therefore further illustrate it by Examples from thence: And to what hath been observed, I further add, That the sides by which the aforesaid Bubbles of the Pith are circumscribed, are not meer paper skins, but

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but so many several ranks or piles of exceeding small Fibrous Threds, lying for the most part evenly one over another from the bottom to the top of every Buble, and running cross, as the Threds in the Weavers Warp, from one Buble to another; which is to say, That the Pith is nothing else but a *Rete mirabile*, or an infinite number of small Fibres admirably complicated together; as by cutting the Pith with a Razor may be seen.

All Vegetables exhibit this spectable not alike distinctly, those best with the largest Bubbles. Nor the same Pith in any condition, but best when dry; because then, the Sap being voided, the spaces betwixt the fibrous Threds, and so the Threds themselves are more distinctly discernable. Yet is it not to be dried after cutting; because its several parts will thereupon coincide and become deformed; but to be chosen while the plant is yet growing, when it may be often found dry, yet undeformed, as in the Trunks of common Thistle, Jerusalem Artichoke, &c.

These Threds, so far as I can observe, are not single Fibres, but usually consist of several. Nor are they simply collateral, but by the weavage of other single ones, in their natural estate, knit together; much after

after the same manner as the Spiral Fibres of the Air-vessels. This connexion I have nowhere so well seen, as in the white bottoms of the Bubbles of a Bulrush, being cut transverse; wherein they have the appearance of very fine and close Needle-work.

The single fibres are seldom and scarcely visible, except by obliquely tearing the Pith; by which means they will appear, through the Glass, broken off sometimes a quarter or half an inch, or an inch in length; and exceeding small beyond the Threads. In Bulrush they are sometimes discernable in cutting by the length. These Fibres and the Threads composed of them, being for the most part so pellucid, and closely situate, they frequently seem to make one entire body, as a piece of Ice or a film of Water it self: or even as Animal Skins sometimes shew, which yet are known and commonly allowed to be Fibrous.

The situation of these Threads, is contrary to that of the Vessels, as those by the length, so these chiefly by the breadth of the Root, or horizontally from one edge of the Pith to the other. They are continued circularly; whereby as oft as they keep within the compass of the several Bubbles, the said Bubbles are round; but where they wind out of one Bubble into another, they mutually

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ally intersect a Chord of their several Circles, by which means the Bubles become angular.

The Contexture likewise both of the Parenchymous part of the Bark, and of the diametral Portions inserted betwixt the Lignous, is the same with this of the Pith now described, that is Fibrous. Whence we understand, How the several Braces and Threads of the Vessels are made: For the Vessels running by the length of the Root, as the Warp, by the Parenchymous Fibres running cross or horizontally, as the Woof, are thus knit and as it were stitched up together. Yet their vestage seemeth not to be simple, as in Cloath; but that many of the fibrous Threads are wrapped round about each Vessel, and in the same manner are continued from one to another; thereby knitting them altogether more closely into one tubulary Thred; and those Threads again into one Brace: much after the manner of the Needle-work called Back Stitch, or that used in quilting of Balls. Some obscure sight hereof may be taken in the threds of Cambrick in the use of a Microscope; but it is most visible in the Leaves and Flowers of some Plants. The Delineation of these things I shall therefore omit, till we come hereafter to speak of those parts.

From

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From what hath been said, it may be conjectured; That the Air-vessels successively appearing in the Bark, are formed, not out of any fluid matter, as are the original ones, but of the Parenchymous Fibres; *sc.* by changing them from a spherical to a tubular, and from a circular to a spiral posture.

From the precedents it is also manifest, That all the Parenchymous parts of a Root are Fibrous. Whence it is probable, That all the parenchymous parts of Animals are likewise fibrous, even of the Glandules and of all the Viscera: which yet through the fineness of the work, and less consistency of the parts, may here be more difficult to observe.

And lastly, That the whole body of a Root consisteth of Vessels and Fibres. And that these fibres themselves are tubular or so many more Vessels, is most probable: There only wanteth a greater perfection of Microscopical Glasses to determine. Whence it is also probable, That all the parts of an Animal, even Bones themselves, upon the original formation of the *Fœtus*, are composed of Vessels; or at least of Vessels and Fibres. For which conjecture I have further grounds which I shall not now mention.

The

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The Contents of the Pith are, sometimes Liquor, and sometimes a vaporous Air. The Liquor is always limpid, as that of the Parenchymous part of the Bark; and in nature not much differing from it. The Air is sometimes less, and sometimes more vaporous than that of the Bark. By this Air I mean that which is contained in the Bubbles. Within the Concaves of the Fibres I suppose there is another different one: So that as in the Bubbles is contained a more aqueous, and in the Vessels a more essential Liquor; so sometimes in the Bubbles is contained a more vaporous, and in the Fibres a more simple and essential Air.

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An Account of the

VEGETATION

OF

ROOTS

Grounded chiefly upon the foregoing

ANATOMY.

THE THIRD PART.

TO philosophize, is to render the *Causæ* and *Ends* of Things. No man therefore that denieth *God* can do this truly : For the taking away of the first *Cause* maketh all things *contingent*. Now of that which is *contingent*, although there may be an *Event*, yet there can be no *Reason* or

or *End*: so that men should then study that which is not. So the *Causes* of Things, if they are *contingent* they cannot be *constant*: for that which is the *Cause* of this now, if it be so contingently, it may not be the *Cause* hereafter; and no *Physical* Proposition grounded upon the *Constancy* and certainty of things could have any foundation. He therefore that philosophiseth, and denieth *God*, playeth a childish game.

Wherefore *Nature* and the *Causes* and *Reasons* of things duly contemplated, naturally lead us unto *God*, and is one way of securing our veneration of Him; giving us not only a general demonstration of his *Being*; but a particular one of most of the several *Qualifications* thereof. For all *Goodness*, *Righteousness*, *Proportion*, *Order*, *Truth*, or whatever else is excellent and amiable in the *Creatures*, it is the demonstration of the like in *God*: for it is impossible that *God* should ever make any thing not like himself in some degree or other: these things, and the very Notion which we have of them, are *Conceptions* issuing from the *Womb* of the *Divine Nature*.

By the same means we have a greater assurance of the excellency of his *Sacred Word*; that he who hath *done* all things so transcendently well, must needs *speak* as

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well as he hath *done*. That He who in so admirable a manner hath *made* man, cannot but know best what his true *Principles* and *Faculties* are, and what *Actions* are most agreeable thereunto; and that having adorned him with such *beauteous* and *lovely* ones, it is impossible he should ever put him upon the exercise of those *Faculties* in any way *deformed* and *unlovely*. That he should do all things so well *himself*, and yet require his *Creatures* to do otherwise, is unconceivable.

And as we may come hereby to rectify our apprehensions of his *Laws*, so also of his *Mysteries*. For there are many things of the *manner* of whose existence we have no certain knowledge, yet of their *existence* we are as sure as our senses can make us: but we may as well deny what *God* hath made, *To be*; as what he hath spoken, *To be true*, because we understand not *how*. And the knowledge of *Things* being gradually attained, we have occasion to reflect, That some things we can now well conceive, which we once thought unintelligible: I know therefore what I *understand* not, but I know not what is *unintelligible*; what I know not now, I may hereafter; or if not I, another; or if no man, or other *Creature*, it is sufficient that *God* fully understandeth

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derstandeth himself. It is not therefore the *knowledge* of Nature, but the *wanton phantasies* of mens minds that dispose them either to forget *God*, or to think unduly of him.

Nor have we reason to fear going too far in the Study of Nature, more than the entering into it; because the higher we rise in the true knowledge and due contemplation of *This*, the nearer we come to the *Divine Author* hereof. Or to think, that there is any contradiction, when *Philosophy* teaches that to be done by *Nature*, which *Religion* and the *Sacred Scriptures* teach us to be done by *God*: no more than to say, that the *Balance* of a *Watch* is moved by the next *Wheel*, is to deny that *Wheel* and the rest to be moved by the *Spring*, or that both the *Spring* and all the other parts are caused to move together by the *Maker* of them. So *God* may be truly the *Cause* of *This* effect, although a thousand other *Causes* should be supposed to intervene; for all *Nature* is as one great *Engine* made by and held in his hand. And as it is the *Watch-makers Art*, that the *Hand* moves regularly from hour to hour, although he put not his finger still to it: so is it the demonstration of *Divine Wisdom*, that the Parts of *Nature* are so harmoniously contrived and set together as to conspire to all kind of natural motions

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ons and effects without the extraordinary immediate influence of the *Author* of it.

Therefore as the *Original Being* of all things is the most proper demonstration of *Gods Power*, so are the *Successive Generations* and *Operations* of Things the most proper demonstration of his *Wisdom*. For if we should suppose *God* did now make or do any thing by any thing, then no *Effect* would be produced by a *natural Cause*; and consequently He would still be upon the Work of *Creation*, which yet *Sacred Scripture* asureth us he *reseteth from*; and we might expect the formation of a Child in an Egg, as well as in a *Womb*, or of a Chicken out of a *Stone* as an Egg; For *Infinite Power* maketh no difference in the things it useth. But in that these things are not only *made*, but *so made* as to produce their *natural effects*, here is the sensible and illustrious evidence of his *Wisdom*; and the more complicated and vastly numerous we allow the *natural Causes* of things to be, the more duly we conceive of that *Wisdom* which thus disposeth of them all to those their *Effects*. As the *Wisdom* of the *King* is not seen by his interposing himself in every Case; but in the contrivance of his *Laws*, and constitution of his *Ministers* in such sort, that it shall be as effectually determined of, as if he

he did so indeed. Thus all things are as *Ministers* in the hands of *God*, conspiring together a thousand *ways* towards a thousand *effects* and *ends* at one time; and that with the same certainty as if he did propose that omnipotent *Fiat* which he used at the Creation of the World, to every one of them.

This *Universal Monarchy*, as it is eminently visible in all other particular *Oeconomies*; so is it no less in that of *Vegetables*. Infinite occurrences and secret Intrigues 'tis made up of, of which we cannot skill but by the help of manifold *Means*, and those I suppose such as I have lately propounded. As yet I have prosecuted only one of them, *scil. Anatomy*, and that not thoroughly neither. So far therefore as Observations already made will conduct us, I shall endeavour to go. And if, for the better clearing of the way, I have intermixed some Conjectures, I think they are not meerly such, but for which I have some grounds, and which the Series of the following Discourse may be some proof of.

Let us say then, that the Root of a Plant being lodged in some Soil for its more convenient growth; 'tis necessary the Soil should be duly prepared thereunto. The Rain therefore falling and soaking into it;

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somewhat diluteth the dissoluble *Principles* therein contained, and renders them more easily communicable to the *Root*, being as a *Menstruum* which extracteth those *Principles* from the other greater and useleſs part of the Soil.

And the warm *Sun* joyned with the mol-
lifying *Rain*, by both, as it were a *Digesti-
on* of the Soil, or a gentle *Fermentation*
amongst its several parts, will follow: where-
by the dissoluble parts therein will rot and
mellow; that is, those *Principles* which as
yet remained more *fixed*, will now be fur-
ther *resolved and unlocked*, and more copi-
ously and equally spread themselves through
the body of the Soil.

These *Principles* being with the growth
of Plants continually exhausted, and need-
ing a repair; the successions therefore of
wet, wind, and other weather, beat down
and rot the Leaves and other parts of Plants:
whereby (as *Weeds* which are wont to be
buried under ground) they become a *natu-
ral Manure*, and re-impregnate the Soil;
being thus, in part, out of their own resol-
ved *Principles*, annually compounded a-
gain.

Many of these *Principles* upon their *resolu-
tion* being by the *Sun* more attenuated
and volatilized, continually ascend into the
Air,

Air, and are mixed therewith. Where although they lose not their vegetable Nature, yet being amongst other purer *Principles*, these also, depositing their earthy feculencies, become more subtile, simple and essential bodies.

And the *Air* being of an *Elastic* or *springie* Nature, pressing more or less upon all bodies; it thereby forceth and insinuateth it self into the Soil through all its permeable pores. Upon its own entrance, it carries also many of the said *Vegetable* and *essential Principles* along with it, which together with the rest are spread all over the body of the Soil. By which means, though a less vehement, yet more subtile *Fermmentation*, and with the least advantage of warmth continuable, will be effected.

The *Principles* being thus farther *resolved* and subtilized, would presently exhale away, if the *Rain* again did not prevent: which therefore falling upon and soaking through the Soil, is as a fresh *Mensstruum* saturate or impregnate with many of them, and as it still sinketh lower, carries them along with it from the superficial to the deeper parts of the Soil; thus not only maturing those parts also, which otherwise would be more lean and cold; but therein likewise laying up and securing a store more

more gradually and thriftily to be bestowed upon the upper parts again as they need.

And Autumn having laid up the store, Winter following thereupon, doth as it were lock the doors upon it. In which time some warmer intervals serve further and gradually to mature the stored *Principles*, without hazard of their being exhaled. And the Spring returning, sets the doors open again, with warmer and more constant *Sun*, gentle and frequent *Rain* fully resolves the said *Principles*, and so furnisheth a plentiful diet for all kind of *Vegetables*; being a Composition of *Water* chiefly, wherein are resolved some portion of *Earth*, *Salt*, *Acid*, *Oyl*, *Spirit*, and *Air*; or other bodies of affinity herewith.

The *Root* standing in the Soil thus prepared, and being always surrounded with a *Bark*, which consisteth chiefly of a *parenchymous* and spongy body; it will thus, as Sponges do, naturally suck up the watry parts of the Soil impregnate with the said *Principles*. Which *Principles* notwithstanding being in proportion with the watry parts but few, and also more *essential*, and though *mixed* yet as yet little *united*; therefore in this *parenchymous* part, are they never much discovered either by colour, taste,

taste, or smell. As it is probable that some distilled *Waters* which discover nothing to sense of the Plants from which they are distilled, may yet in part retain their *Faculties*. And it is known that many bodies, as *Crocus Metallorum*, convey many of their parts into the *Menstruum* without any sensible alteration thereof. So *Frost* and *Snow* have neither taste nor smell; yet from their *Figures*, 'tis evident that there are divers kinds of *Saline Principles* incorporated with them, or at least such as are common to them and divers kinds of *Salts*.

The entrance of this impregnate Water or *Sap* is not without difference, but by the regulation of the intervening *Skin*; being thereby *strained* and rendred more pure: the *Skin*, according to the thickness or closeness thereof, becoming sometimes only as a *brown paper*, sometimes as a *Cotton*, and sometimes as a *Bag of Leather* to the transient *Sap*, as the nature of it doth require. By which it is also *moderated*, lest the *Bark* being spongy, should suck it up too fast, and so the *Root* be as it were surcharged by a *Plethora*. And divers of the *succiferous Vessels* being mixed herewith, and because lying next the Soil, usually more or less *mor-tified*, and so their *Principles* somewhat *resolved*; the *Sap* is hereby better *specified*,
and

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and further *tinctured*, such parts of the *Sap* best entering as are most agreeable to those *Principles*, and carrying them off in some part as it passeth into the *Bark*.

The *Sap* thus *strained*, though it be *pure*, and consisteth of *Essential* parts; yet being *compounded* of *heterogeneous* ones; and received into the *Parenchyma* of the *Bark* a light and spongy body, they will now easily and mildly *ferment*. Hereby they will be yet further prepared. And also more easily insinuate themselves into all the *Bubbles* of the said *Parenchyma*; swelling and dilating it as far as the continuity of its parts will bear. Whereupon partly from the continued entrance of fresh *Sap*, and partly by a motion or pressure of *restitution* in the swollen and tensed *Bubbles* of the *Parenchyma*, the *Sap* is forced thence into the other parts of the *Root*.

And because the *Parenchyma* is in no place openly and visibly pervious, but is every where composed of an infinite number of small *Bubbles*; the *Sap* therefore is not only *fermented* therein, and fitted for separation; but, as it passeth through it, is every part of it *strained* an hundred times over from *buble* to *buble*.

The *Sap* thus *fermented* and *strained*, is distributed to the *Organical* parts, according

ing as the several *Principles* of this, are agreeable to those whereof the said *Organical* parts consist. As the *Sap* therefore passeth from *buble* to *buble*, such *Principles* as are agreeable to those of the *Fibres* of the said *Bubbles*, will adhere to, and insinuate themselves into the body of the *Fibres*; *sc.* *earthy* and *watry* chiefly, next *acid*, then *Spirituos* and *oleous*, and least of all *airy*.

And the *Sap* by its continual appulse and *percolation*, as it leaveth some parts upon the said *Fibres*; so as it is *squeezed* betwixt them from *buble* to *buble*, it licks and carries off some others from them, in some *union* together with it; and so is impregnate herewith, as *Water* by passing through a *Mineral Vein* becomes *tinctured* with that *Mineral*.

The *Sap* thus impregnate with some *united Principles* of the *parenchymous Fibres*, passeth on to the *succiferous Vessels*, whereinto their correspondent *Principles* also enter; *scil.* *earthy*, *watry*, *saline*, and *oleous* chiefly. And because the *parenchymous Principles* mixed with them are in some degree *united*, and so more ready to *fix*: some of these therefore will likewise enter into the said *Vessels*. Whereupon, the *Alkali oleosum* of the one, and the *Acidum Spirituosum* of the other meeting together, these

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these with the other *Principles* all *concentre*, and of divers *fluids*, become one *fixed body*, and are gradually *agglutinated* to the *Vessels*, that is the *Vessels* are now *nourished*.

The supply of the *Sap* still continued, the *Principles* thereof will not only enter into the *Body* of these parts, but their *Cavities*. And the *parenchymous Fibres* being *wrapped* about the *Vessels*, as often as the said *Fibres* are more *turgid* with their own contained *fluid*, they will thereby be somewhat *shortened*, or contract in length; and so must needs *bind* upon the *Vessels*, and thereby as it were *squeeze* some part of the *fluid* contained both within themselves and the *Vessels* back again into the *Bubbles*.

The *Sap* herein being thus *tinctured* with some of the *united Principles* of the *Vessels*, divers of them will now also *infiltrate* themselves into the *parenchymous Fibres*, and be incorporated with them; whereby these which before were only *relaxed* and *dilated*, are now also *nourished*, and not till now. Some portion of the *united Principles* of both parts being necessary to the true *nutrition* of each; as the confusion and joyn't assistance of both the *arterious* and *nervous Liquors* is to the nourishment of the parts in *Animals*.

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Some portion of the *Sap* thus doubly *tinctured*, is at the same time transmitted to, and enters the *body* of the *Air-vessels*; consisting chiefly of *Earth, Water, Air, and Acid*; and in like manner as in the other parts herein *agglutinated*. And the appulse and pressure of the *Sap* still continued, some parts hereof are also trajected into the *Concaves* of the said *Vessels*; existing therein as a most compounded *fluid*, partaking more or less both of the *Principles* and *Textures* of the other *Organical* parts and of their own containing *Vessels*, and is, as it were, a *mixed Resolution* from them all.

And the *parenchymous Fibres* being *wrapped* about these as the other *Vessels*, and in like manner *binding* upon them, thus frequently *squeezeth* part of their contained *fluid* out again, as necessary, though not to the immediate nourishment of the parts, yet the due qualification of the *Sap*; being a constant *aerial Ferment* successively stored up within the *Air-vessels*, and thence transfused to the *Sap* and other parts.

And that there may be a better transition of the *Sap* thus *tinctured* to the several *Organical* parts; therefore none of them are close set and compact within themselves severally; for so they would be inaccessible to the *Sap*, and their inward portions wanting

ing a due supply of aliment would be starved : but the *Vessels* both of *Air* and *Sap* being every where divided into *braced* portions, and other, *parenchymous*, filling up the spaces betwixt them, intermixed ; there is therefore a free and copious communication of the *Sap*, and of all the *Tinctures* successively transfused into it, from part to part, and to every portion of every one of them ; the *parenchymous* portions running betwixt the *Braces*, as the smaller *Vessels* do amongst the other parts in *Animals* ; whereby none of them want that due matter which is necessary either for their nutrition, or the good estate of their Contents.

For the due distribution of the several parts of the *Sap*, *Diametral* portions of the *parenchymous* Body run sometimes directly through the *Bark*, as in *Louage*, *Parley*, &c. and so are all or most of them continuous betwixt both the *succiferous* and *Air-vessels* from the circumference to the centre ; there- by carrying off a more copious and *aerial Ferment* from the one, and communicating it unto the other. For as the *Sap* enters the *Bark*, the more *liquid* parts still pass into the *succulent* portions thereof ; the more *airy* is separated into those white and dryer *diametral* ones ; and in its passage betwixt

betwixt the *portions* of the *Air-vessels*, is all along communicated to them. Yet is it not a pure and *simple Air*, but such as carries a *Tincture* with it from the *succiferous Vessels*: and therefore when the *diametral* portions are more distant, the *vessels* run not in a straight line betwixt them, but are reciprocally inclined so, as to touch upon them, as in *Lodge* is visible; thereby communicating their *Tincture* to the *Air* as it passeth by them through the said *diametral* portions.

By the continual appulſe of fresh *sap*, some both of the *airy* and all the other parts thereof, are transmitted into the *Pitb*; where finding more room, it will yet more kindly be *digested*. Especially having the advantage herein of some degree of warmth, being remoter from the Soil, and as it were *tunn'd* up within the *Wood*, or the *Mass* of surrounding *Vessels*. So that the *Pitb* is as it were a *Repository* of better *Aliment* gradually supplied to those *succiferous Vessels* which are frequently scattered up and down therein, and which ascend into the *Trunk*. But where no *succiferous Vessels* are mixed herewith, it usually becomes dryer, and is replenished with a more *aerial* and warmer *sap*; whereby the growth of the *Caulis* is promoted as by an *hot Bed* set just under it.

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And thus all the *Parts* have a fit *Aliment* provided for their *nourishment*.

In this *Nourishment* the *Principles* of the *Sap* are, as is said, *concentred*, and *locked up* one within another : whence it is that the *Organical* parts, being cleansed of their *Con- tents*, have none of them any *taste* or *smell*, as in the *Piths* of Plants, *Paper* and *Linen Cloth* is evident ; because till by *digestion*, violent *distillation* or some other way they are *resolved*, they cannot act upon the *Organs* of those senses. For the same reason they are never *tintured* excepting by their *Contents* ; and although to the bare eye they frequently shew *white*, yet viewed through a *Microscope* they all appear *transparent*. In like manner as the *Serum* of *Blood*, *Whites* of *Eggs*, *Tendons*, *Hairs*, and *Horns* themselves are *transparent*, and without much *smell* or *taste*, their *Principles* being in all of them more or less *concentred* ; but being forcibly *resolved*, are ever variously *invested* with all those *Qualities*.

And as from the *Concentration* of the *Principles* in every *Organical* part they all agree thus far ; so from the *Predominion* of those of each part the rest are controuled, not only to a *Concentration*, but an *Assimilation* also, and their respective properties are thus preserved. Hence the *succiferous Vessels*

Vessels are always *tough* and most pliable; for so are all *Barks* wherein these *Vessels* abound: so are the *Twines* of Flax, which are nothing else but the *succiferous Vessels* of that Plant. For *sal Alkali*, *Oyl*, *Water*, and *Earth* are, as is said, the predominant *Principles* of these *Vessels*. Now it is the *Oyl* chiefly by which Bodies are *tough*: for being of it self viscous and tenacious, by taking hold of other *Principles*, marries them together; and the *sal Alkali* and *Earth* *centred* with it, addeth to it more strength. Hence the *Caput Mortuum* of most Bodies, especially those that abound with *Oyl* and *sal Alkali*, are *brittle* and friable; those *Principles*, which were the Ligaments of the rest, being forced away from them. Hence also the *parenchymous* parts of a *Root* are *brittle* and friable; *sc.* because their *earthy*, and especially *oleous* and *saline Principles* are, as is said, so very few. Therefore all *Piths* and more *simple Parenchyma's* break *short*; so *Corn*, and the *Roots* of *Potatoes*, and divers other Plants being dried, will easily be rub'd to *Meal*; and many *Apples* after Frosts eat *mealy*; all which parts have the Analogy and Essence of *one* only *Body*.

And as the *Consistence* of the several *Organical* parts is dependent on their *Principles*,

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ciples, so are their *Figures*. And first the *Succiferous Vessels* from their *Sal Alkali* grow in length; for by that dimension chiefly this *Salt* always *shoots*; and being a less moveable *Principle* than the rest, and so apt more speedily to *fix* or shoot; thus overrules them to its own *Figure*. And even as the shape of a *Button* dependeth on the *Mould*, the Silk and other Materials wrought upon it, being always conformable thereto: so here; the *Salt* is as it were the *Mould*, about which the other more passive *Principles* gathering themselves, they all consort and fashion to it. Hence also the *Vessels* are not *pyramidal* as *Veins*, but equally thick from end to end; the shootings of the said *salt* being also figured by the like *dimension*. And as by the *saline Principles* the *Vessels* are *long*, so by the *oleous* they are every where *round* or properly *Cylindrical*; without some joynt efficacy of which *Principle* the said *Vessels* would be *flat*, or some way edged and *angular*, as all *saline* Shoots of themselves are, as those of *Alum*, *Vitriol*, *Sal Armoniac*, *Sea Salt*, *Nitre*, &c. And because the *spirituous* and more *fluid* portion of the *Principles* is least of all apt to *fix*; while therefore the other parts *fix* round about, this will remain moveable in the *Centre*; whence every

every *Vessel* is formed, not into a solid but hollow *Cylinder*, that is, becomes a *Tube*.

The *Lactiferous Vessels* are *tubular*, as the *Lymphæducts*, but of a somewhat wider *Cave*. For being their *Principles* are less earthy and *oleous*, and also more loosely concentrated; as from their easie corruption or *resolution* by the *Air*, it appears they are; they are therefore more tender; & so more easily dilative and yielding to the said *Spirituons* portion in the Centre. Whence also they are more adapted to the free motion of the milk *Content*; which being an *oleous* & thicker Body, and having no advantage of *pulsation* as the Blood in *Animals*, might sometimes be apt to stagnate, if the *Vessels*, through which it moves, were not somewhat wider.

As the *Saline Principles* are the *Mould* of the *Succiferous*, so are the *aerial* of the *Air-Tubes*. Now the Particles of *Air* I suppose are all *crooked*, and many of them *spiral*; which from the *Elastic* Nature of the *Air* is probable; being capable both of dilatation and angustation by force; which it could not be, if its Particles were straight and not crooked, nor so well by being all of them *simply* crooked, as if some of them were also *spiral*. Wherefore the said *spiral* and other *crooked* Particles of the *Air* first shooting and setting together as the *Mould*,

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the other *Principles* cling and *fix* considerably round about them: so that as by force of the *Saline Principles* the rest are made to shoot out in long continued *Fibres*; so by force of the *Aerial*, those *Fibres* are still disposed into *Spiral Lines*, thus making up the *Air-vessels*. And according as fewer of these *Aerial* Particles are in proportion to the *Saline*, the *Concave* of the *Air-vessels* is variously wider, or the *Fibres* continue their shooting by wider *Rings*, as those that come nearer to a *right Line*, and so are more compliant to the *Figure* and shooting of the said *Saline* parts. And whereas the *Succiferous Vessels* shooting out only in length are never sensibly amplified beyond their original size; these on the contrary, always more or less increase their *Diameter*, because their *Fibres* being disposed into *Spiral lines*, must needs therefore, as they continue their growth, be still dilated into greater and greater *Rings*. And being at the bottom of the *Root* more remote from the *Air*, and so having somewhat fewer Particles purely *Aerial* their ingredient to them, then at the top, they fall more under the government of the *Saline*, and so come nearer to a *right Line*, that is into greater *Circles*, and so the *Air-vessels*, made up of those *Circles*, are there generally wider.

By

Part III. of Roots.

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By mediation of their *Principles* the *Perichymous* parts likewise of a *Root* have their proper *Texture*. For from their *acid Salt* they are *fibrous*; from their *Oyl* the *Fibres* are *round* and in all parts even within themselves; and from their *Spirit* it is most probable that they are also *hollow*. But because the *Spirit* is here more copious than the *Air*; and the *Saline Principle* a *salsacidum*, and more under the government of the *Spirit* than an *Alkali*; therefore are not the said *Fibres* continued in *Straight* lines, as the *Succiferous Vessels*; or by one *uniform* motion into *Spiral* lines, as the *Fibres* in the *Aerial*; but winding in a circular manner to and fro a *thousand ways*, agreeable to the like *motions* of the *Spirit*, that most *active*, and here most *predominant*, *Principle*. And the *Spirituos* parts being, as is said, here more copious and redundant, they will not only suffice to fill up the *Concaves* of the *Fibres*, but will gather together into innumerable little spaces up and down without them: whence the *Fibres* cannot winde and wreath close together, but are forced to keep at some distance one parcel from another, and so are disposed, as Bread is in baking, into *Bubbles*.

And the under *Fibres* being *set* first as the

the *Warp*, the *Spiritous* parts next adjacent will incline also to *fix*, and so govern an over-work of *Fibres* wrapping as the *Woof* in still smaller Circles round the other, whereby they are all knit together. For the same reason the *Succiferous Vessels* being first formed, the *Parenchymous Fibres* set and wrap about these also. And the *Air-vessels* being formed in the Centre, the *succiferous* run along those likewise; as *volatile Salts shoot* along the sides of a Glass, or *freeze* upon a Window; and so are as it were incrustate about them in a Ring.

All the more athermal and subtile parts of the *Air*, as they stream through the *Root*, it should seem do gradually dispose the *Air-vessels* where there are more of them, into *Rays*. Therefore in the inferior parts of the *Root* they are less regular, because more remote from the *Air*. And in the upper parts of many *Roots*, as *Cumfry*, *Borage*, *Parsnep*, where those that are next the Centre are confused, or differently disposed; those next the *Bark* and so nearer the *Air*, are postured more regularly and always into *Rays*. For the same reason it may be; that the *Succiferous Vessels* in the *Bark* where the *Air vessels* are more numerous, are usually disposed into *Rays*; and that the *Parenchyma* of the *Bark* is disposed into

Diamet.

Diametral Portions; and that where the *Air-vessels* are fewer or smaller, these *Portions* are likewise smaller or none, as in *Chervil, Asparagus, Taraxium, Orpine, Rislort, Horse-Radish, Potato's, &c.*

The said ætherial parts of the *Air* have a power over the *Air-vessels*, not only thus to dispose them; but also to sollicit and spread them abroad from the Centre towards the Circumference of the *Root*; which power, in speaking according to vulgar sense, I take leave to call Attraction. This Attraction or *Magnetick power* betwixt the *Air* and these *Vessels* may be argued, from the Nature of the *Principles* common to them both. From the *Electral* Nature of divers other Bodies, the *Load-stone* being not the only one which is attractive. And from the spreading of these *Vessels* always more or less at the upper part of the *Root* where nearer to the *Air*: which is not merely the spreading of the whole *Root*, but a particular motion of these *Vessels* visibly encroaching farther upon the *Bark*. And from other Effects hereafter mentioned.

The spreading of these *Vessels* is varied, not only according to the *force* the *Air* hath upon them; but their own *aptitude* to yield thereto. As oft therefore as they are slenderer, they will also be more pliable and
recessive.

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recessive from the Centre towards the Circumference : hence in such *Roots* where they are small they stand more distant , as in *Turnep*, *Jerusalem Artichoke*, *Potato's*, and others ; and so their *Braces* are fewer ; and in the same *Root*, where they are smaller, their distance is greater. Besides, in these smaller *Air-vessels*, the *Rings* being less, and the *Spiral Fibres* whereof they are made continuing to shoot ; the said *Rings* therefore must needs be so many more , as they are smaller, and so take up more space by the length of the *Root* ; and so not being capable of being crowded in a right line, every *Vessel* will be forced to recede to a crooked or bowed one.

The *Succiferous Vessels*, being by the *parenchymous Fibres* knit to *These*, will likewise comply with their motion and spread abroad with them. Yet being still smaller and more pliable than the *Air-vessels*, and so more yielding to the intercurrent *Fibres* of the *Parenchyma*, their *braced Threds* will sometimes be much more divaricated, than these *Air-vessels*, as in *Jerusalem Artichoke*. And because the *Succiferous Vessels*, although they are joyned to the *Aerial* by the *parenchymous Fibres*, yet are not continuous with them ; neither fall under the like attractive power of the *Air* as the *Aerial* do ;
the

the *Aerial* therefore upon their spreading, do not always carry all the *Succiferous* along with them, but often, if not always, leave many of them behind them sprinkled up and down the *Pilb*; as in *Parley*, *Carrot*, *Jerusalem Artichoke*, *Turnep*, &c. may be seen.

The spreading of the *Air-vessels* still continued, several of them at length break forth beyond the circumference of the *Root*, and so are distributed, either in the lower parts into *Branches* and *Strings*, or at the top into *Leaves*. And least they should all spread themselves into *Leaves*, and none be left for the *Caulis*; as where they are very small, or the *Succiferous Vessels* to bound them are but few, they might; therefore divers of them are oftentimes more frequently *braced* in the Centre; for which reason they cannot so easily separate and spread themselves from thence, but run more inwardly up into the *Caulis*, as in *Borage*.

From the various *Sizes*, *Proportions*, and *Dispositions* of the Parts, *Roots* are variously *sized*, *shaped*, *moved*, and *aged*. Those that by annual growth are large, have fewer both *Aerial* and *Succiferous Vessels*, and a more copious *Parenchyma*. So that the *Aerial Vessels*, or rather the *Airy Ferments* contained

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contained in them, *volatilizing* a smaller portion of the *Sap* ; this therefore being less capable of advancement into the *Trunk*, must needs remain and *fix* more copiously in the *Root*, which is thereby more augmented. So where the *Succiferous Vessels* are few, the *Root* is yet proportionably large ; and where they are numerous, it is never so, as to its annual growth, in any proportion to their number ; because their *Tincture* will go farther in *setting* the *Parenchymous* parts, than the *Tincture* of these will in *setting* them.

When the *Aerial Vessels* are more pliable and sequent to the attraction of the *Air*, and so spread themselves, and the *Succiferous* together with them more abroad ; in the manner as hath been said ; the *Root* also will grow more in breadth ; the nutrition of the *Parenchymous* parts, to which the *Vessels* are adjacent, being thus by the same dimension more augmented ; as in *Turnep*, *Jerusalem Artichoke*, &c. But where these are not spread abroad, the *Root* is but slender ; as in *Asparagus*, *Dandelion*, &c.

The *Vessels* as they thus spread and move towards the circumference, because the *Fibres* of the *Parenchyma* are no where *interculated* or continuous with them, but only *wrapped* about them, and their motion so exquisitely

exquisitely slow ; therefore they make not their passage through the said *Parenchyma* by tearing of it, or causing any *rupture* ; but only by *slipping* themselves along its *Fibres*, as it were from *Buble* to *Buble*, (as we are wont the *Rings* of a *Tarring Iron*) and so as they move forward themselves, leave the said *Fibres* behind them all knit together in the Centre, thus either *making* or *augmenting* the *Pith*.

If the *Aerial Vessels* be contracted, and somewhat large or numerous, and the *Succiferous* also more copious round about them ; the *Root* grows very long, as those of *Fenil*, *Vine*, *Liquorish*, &c. For the *Aerial Vessels* containing a more copious *Ferment*, it will well digest and mature the *Sap* ; yet the *Succiferous* being over proportioned to them, it will not therefore be so far volatilized as to ascend chiefly into the *Trunk*, but only to subserve a fuller growth of these *Vessels* : and these being more numerous, and so more sturdy, and less sequent to the expansive motion of the *Aerial* ; this their own growth, and consequently that of all the other parts, cannot be so much in breadth as length.

Where the same *Aerial Vessels* are fewer, or more contracted, or sheathed in a thicker and closer *Bark* ; the *Root* is smooth, and less

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less Ramified ; as in *Asparagus*, *Peony*, *Taraxicum*. But where more numerous, sheathed in a thinner *Bark*, smaller, more dilated ; the *Root* is more Ramified, or more Stringy, as in *Columbine*, *Clary*, *Beet*, *Nicotian*. For being, as is said, by these means, more sequent to the Attraction of the *Air*, approaching still nearer the circumference of the *Bark*, they at last strike through it into the *Mould*. And the *parenchymous Fibres* being wrapped about them, and the *Succiferous Vessels* knit to them by those *Fibres* ; therefore they never break forth naked, but always invested with some quantity of these parts as their *Bark* : where by whatever essential part is in the *main Body* of the *Root*, is also in every *Branch* or *String*.

From the same expansion and pliability of the *Air-vessels*, the *Root* oftentimes pisseth forth *Root-buds* ; in the formation of which *Buds* they are pliable and recessive all kinds of ways ; being not only invited outward toward the circumference of the *Root*, as in *Root-strings* ; but spread more abroad every way in the *Bud* ; whereas in the said *Root-strings* they are always more contracted ; which, in respect of the disposition of the *Parts*, is the principal difference betwixt the *Root* and the *Trunk*. Hence those *Roots* chiefly have *Root Ends*, which have

have the smallest *Air-vessels*; these, as is said, being most pliable and expansive.

But because the expansiveness of the *Vessels* dependeth also in part upon the fewness of their *Braces*; therefore the *Buds* shoot forth differently in divers *Roots*. Where fewer, they shoot forth beyond the circumference of the *Root*, as in *Jerusalem Artichoke*; where more close, as in *Potatoes*, the *Buds* lie a little absconded beneath it, the *Air-vessels* being by their *Braces* somewhat checked and curbed in, while the *Bark* continueth to swell in a fuller growth.

If the *Aerial Vessels* are all along more equally sized, the *Root* is so also, or *Cylindrical*; as those of *Eryngo*, *Horse-Radish*, *Mursh-mallow*, *Liquorish*, &c. But if unequal, growing still wider towards the bottom of the *Root*; the *Root* is unequal also, but groweth, quite contrary to the *Air-vessels*, still smaller or *pyramidally*; and the more numerous and larger the *Vessels* are, the *Bark* is proportionably the less, and so the *Root* more sharp and spiring, as in *Borage*, *Nettle*, *Patience*, *Thorn Apple*, &c. For here where the said *Air-vessels* are wider, they contain a more copious *Ferment*, whereby the *Sap* is thereabout more volatilized, and copiously advanced to the upper parts. Withal, thus receiving within them-

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themselves, and transmitting to the upper parts a more plentiful *Vapour*, they hereby rob the *parenchymous* parts of their aliment, and so stint them in their growth.

From the different *proportion* and *situation* of the parts, the *Motions* of the *Root* are also various. For where the *Air-vessels* are spread abroad and invested with a thinner *Bark*, the *Root* runs or lyes *level*, as in the *level Roots* of *Primrose*, *Ammi*, *Anemone*, &c. may be seen. So that these *Roots* as by the *perpendicular* ones shooting from them into the *Moulds* they are plucked down; so by the *Air-vessels*, standing nearer the *Air* and more under its attractive power, they are invited upwards; whereby they have neither *ascent* nor *descent*, but keep *level* betwixt both.

But if these *Vessels* are contracted standing either in or near the Centre, and are invested with a *Bark* proportionably thick; the *Root* striketh down *perpendicularly*, as *Dandelion*, *Bugloss*, *Parsnep*, &c. Therefore the said *Vessels*, although they are spread abroad in the *level*, yet in the *perpendicular Roots* of the same Plant they are always contracted; as by comparing the *level* and down right *Roots* of *Ammi*, *Primrose*, *Jerusalem Artichoke*, *Cowslip*, and others, is manifest.

IF

If the *Aerial Vessels* are contracted and environed with a greater number of *Succiferous*, the *Root* grows *deep*, that is, *perpendicular* and *long*; *perpendicular* from the contraction of the *Aerial*, and *long* from the predominion of the *Succiferous*, which in their growth are extended only by that dimension, as in *Liquorish*, *Eryngo*, &c.

If the *Succiferous* are over proportioned to the *parenchymous* parts, but under to the *Aerial*; the *Root* is *perpendicular* still, but groweth *shallow*; the *Succiferous* being sturdy enough to keep it *perpendicular*, and the *Aerial* having a predominion to keep it from growing *deep*; as in *Stramonium*, *Nicotian*, *Beet*, &c.

If on the contrary the *parenchymous* are predominant to the *Aerial*, and that both in the *Root* and *Trunk*; then the whole body of the *Root* changeth place or *descends*: for the said *Aerial Vessels* haveing neither in the *Trunk*, nor in the *Root* a sufficient power to draw it upwards; it therefore gradually yields to the motion of its *String-Roots*; which as they strike into the Soil, pluck it down after them. And because the old *Strings* annually rot off, and new ones successively shoot down into the Soil; it therefore annually still descendeth lower, as in *Tulip*, *Lily*, &c. may be observed.

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Where the *Air-vessels* are much spread abroad and also numerous, the *Root* oftentimes, as to its several parts, *descends* and *ascends* both at once: so *Radiſhes* and *Turneps*, at the same time their aether parts descend, their upper ascend, where therefore the said *Vessels* are more loosely braced and spread much more abroad than in the lower parts. Hence also the upper part of the *Roots* of most *seedlings* ascends; because the first *Leaves* being proportionably large, and standing in a free *Air*, the *Air-vessels* in them have a dominion over the young *Root*, and so yielding themselves to the solicitation of the *Air upwards*, draw the *Root* in part after them.

By the *situation* and *proportions* of the *Part*, the *Age* of the *Root* is also varied. For if the *succiferous Vessels* have the greatest proportion, the *Root* is *perennial*, and that to the farthest extent, as in *Trees* and *Shrubs*: because these *Vessels* containing a more copious both *Alkali* and *Oyl*, and their several *Principles* being more closely concentrated, they are less subject to a *resolution*, that is, a corruption or mortification by the *Air*.

If the *parenchymous* parts have much the greatest, the *Root* seldom liveth beyond two years, but afterwards speiseth either in whole or in-part, as do divers *bulbous*, *tuberous*,

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berons, and other *Roots*; whether they are more porous and succulent, or more close and dry. If porous, all the fluid *Principles* standing herein more abundantly, either by a stronger fermentation, or otherwise, resolve the fixed ones of the *Organical* Parts; whence the whole *Root* rots, as in *Potato* &c. Hence also *Parasneps*, and some other *Roots*, which in a hard and barren *Soil* will live several years, in another more rank, will quickly rot. But if the *Parachymia* be close, then the *Air* chiefly entring in and filling it up, thus mortifies the *Root*, not by rotting the parts, but over drying them, as in *Satyrion*, *Rape* *Crowfoot*, *Monks-hood*, &c.

But if the *Air-vessels* have the greatest, and especially if more large, and withal are spread more abroad; the *Root* is annual, as in *Thorn Apple*, *Nicotian*, &c. For hereby transfusing into all the other parts a more copious *Air*, they are thus by degrees hardned and become sticky, and so impervious to the *Sap*, which should have a free and universal transirion from part to part: as *Bones* by precipitations from the *Blood* at length cease to grow. Or the same more abundant *Air* so far volatilizeth the fluid parts, that they are wholly advanced into the *Trunk*, and so the *Root* is starved. Whence the *Air-*

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vessels

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vessels also of the *Trunk*, where numerous and over proportioned to the bulk of the *Root*, as in *Corn*, they so far promote the advance of the *Sap*, as to exhaust the *Root*, sucking it into a consumption and death.

From the *Principles* of the *Parts*, their *Contents* and the several *Qualities* hereof are also various; the *fluid* of each *Organical* Part being made chiefly by *Filtration* through the sides thereof; such of the *Principles* in the *Sap* being admitted into and transmitted through them, as are aptest thereto: in the same manner as when *Oyl* and *Water* being poured upon a Paper, the *Water* passeth through, the *Oyl* sticks: or as the *Chyle* is strained through the *Coats* of the *Guts* into the *Lacteal Vessels*: or as *Water* in *Purgations*, is strained through the same *Coats* from the *Mesenterical*.

The *Principles* therefore of the *parenchymous Fibres* being *Spirituons*, *acid*, and *aerial*, they will also admit the like into them; excluding those chiefly which are *Alkalizale* and *Oleous*. And as by the *Conjugation* of such *Principles* in the *Fibres*, they like are capable of admittance into them; so the *proportion* and *union* of the same *Principles* regulates their *transmission* into their *Concave*: wherefore the *Principles* of the *Fibres* being chiefly *acid*, next *Spirituons*, and

and least *aery*; the more *aery* ones will be *transmitted*: for if more of *them* should *fix*, they must do so by similitude and adhesion; but where there are fewer similiary parts to adhere to, fewer must adhere. The *Fibres* then contain so many parts of *Air* as to admit many more into their body; but not to *fix* them; which therefore must needs upon admission pass through into their *Concave*; where, together with some other more *spirituons* parts, they make an *etherial fluid*. And because some *aqueous* or *vaporous* parts will also strain through with them; hence it is, that as more and more of these enter, they by degrees still thrust out the *aery* ones, which quitting the more *sacculent Fibres* of the *Parenchyma*, are forced to betake themselves to the dryer ones, *scil.* all those whereof the *diametral portions* do consist. For the same reason the *Aery* parts being gradually excluded the *sacculent Fibres* of the *Bark*; they are forced to recede and transmigrate into those of the *Pith*: And the *Fibres* themselves being filled, and the *Aery* parts still forced into them; they at length also strain through the *Fibres* into the *Vessels*; whence while the *Bark* is *sacculent*, the *Pith* is often filled with *Air*.

The *Lymphæducts* being more *earthy*, *silicious*, *oleous*, and *aqueous*, will both admit

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and copiously *fix* the like *Principles*; yet the *Water* being more *perfluent* than the rest, will therefore *ltrain*, with a lighter *Tincture* of them, into their *Concave*. Especially the *oleous Principles* hereof being *rampant*, and less apt to *fix* and *seize* the *aqueous* parts, upon their entrance, than the *saline*.

But the *Lactiferous* being somewhat less *earthy* and *oleous* than the *Lymphbeducts*, and the *oleous* parts being herein less *rampant*; therefore the *earthy* and *oleous* parts will be both copiously *transmitted* hereinto. So that the *Lymphbeducts* being more *oily*, both *admit*, and *fix* the like *Principles*; the *Lacteals* being moderately *oily*, *admit* them, but *fix* them not, letting them pass through; but the *parenchymous Fibres* being scarce at all *oily*, do not so much as *admit* them.

The *fluid Ferment* contained in the *Air-vessels*, is also in part dependent on the *Principles* of those *Vessels*, being in their percolation *tinctured* therewith. But because the percolation is not made *through* the *bodies* of the *Fibres* whereof the *Vessels* are composed, but only *betwixt* them; therefore the transient *Principles* are not here distinguished so precisely as in all the aforesaid *Organical* parts, but more promiscuously pass into the *Concaves* of the said *Vessels*, and are therein all immersed in a body of *Air*; the

Fibres

Fibres themselves in the mean time, as those of the *Parenchyma*, admitting and containing a more *aery* and *alberial Fluid*.

The *Contents* are varied, not only by the *Nature*, but also the *proportion* and *situation* of the *Parts*, whereby they are in different facility and quantity communicated to one another. Hence it is partly that a *Vine*, and that *Corn* hath so little *Oyl*; *sc.* because their *Air-vessels* in proportion with the other *parts*, are so great and numerous: in *Corn* the *stalk* being also very hollow, and becoming as it were one great *Air-vessel*. For the *oily* parts of the *Sap* are so exceedingly attenuated by the *Aery ferment* contained in these *Vessels*, that they are for the most part so far immersed in the *Spirit*, or mixed therewith, as not, by being collected in any considerable Body, to be distinguishable from it. And the affinity that is betwixt *spirits* and *Oyl*, especially *Essential*, is manifest; both are inflammable *per se*; and burn all away; the *Odors*, which we call the *Spirits* of *Plants*, are lodged in their *essential Oyl*; both being duly *Rectified*, will mix as easily together as *Water* and *Wine*. So that although *Oyl*, by the separation of its *earthy* and *saline* parts, which give it its sensibly *oleous* Body, may not be so far attenuated as to produce a *Spirit*; yet that it may

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may so far, and so be mixed with it, as *not to be discerned from it*, will be granted.

Hence also the *Lactiferous Vessels*, because they stand more remote from the *Aerial*, and the *Succiferous* interpose; the *Liquor* therefore contained in them, is not so much under the government of the *Aerial ferment*, and is thence partly more *oily*. For the same reason, all *Roots* which are *milkie*, so far as I have observed, have an under portion of *Air-vessels*, these being either fewer or smaller.

From the Precedents we may receive some information likewise of the *Odours*, *Colours*, and *Tastes* of *Plants*. And for *Odours*, I suppose that the chief matter of them is the *Aerial ferment* contained in the *Air-vessels*. Not but that the other parts do also yield their smell, but that these yield the strongest and the *best*, and immediately perceptible in *fresh, undried, and unbruised* Plants. For the *Air* entering into, and passing through the *Root*, and carrying a *Tincture* from the several *Organical* and *Contained* Parts along with it; and at last entering also the *Concaves* of the *Air-vessels*; it there exists the most *compounded* and *volatile fluid*, of all others in the *Plant*, and so the fittest matter of *Odour*; and such an *Odour* as answers to the smell of all the *odorous* parts

parts of the *Plant*. Wherefore the *Organical* parts smell not at all, because the *Principles* are, as hath been said, so far fixed and *concentred* together. Hence also the *Contained* themselves, or any other Bodies, as their *Principles* are any way more *fixed*, they are less *odorous*: So is *Rosmelle* than *Turpentine*, and *Pitch* than *Tar*, and many the self same Bodies when they are *coagulated*, than when they are *melted*: So also *Musk*, which is not so liquid as *Civet*, is not so strong; nor *Ambergreece* as *Musk*; for although it hath a more excellent smell than *Musk*, yet yieldeth it not so easily, since it is a more *fixed* Body, and requireth some *Art* to be opened. Hence also the *Leaves* of many Plants lose their *Odour* upon *rubbing*; because the *Air-vessels* being thereby all broken, all their *contained odorous fluid* vanisheth at once, which before only strained gradually through the *Skin*. Yet the *fixed* Parts themselves, upon drying, are so far altered by the *Sun* and *Air*, as to become resolvable and odorous.

So also of their *Colours*. As whence the *Colours* of the *Skins* are varied; for divers of the *succiferous Vessels* together with the *parenchymous* Parts successively falling off from the *Bark* therein; by their proximity to the *Earth* and *Air* their *Principles* are more

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more or less *resolved*, and so produce divers *Colours*. So those *Roots* which turn *purple* any where within, have usually a *black* *skin*; the one of those two *Colours* being by a resolution and corruption of parts easily convertible into the other, as in *Cumfig*, *Thistle*, &c. So the *Milk* of *Scorsonera*, contained in the *Vessels* of the *Bark*, upon drying turneth into a brown *Colour*; wherefore the *skin*, in which there are divers of those *Vessels*, is of the *same*. So both the *Milk* and *skin* of *Louage* is of a brownish *yellow*. But *Paraspe* hath a clearer *Sap* in all its *Succiferous Vessels* and a whiter *skin*. So *Potato's* being cut traverse after some time out of ground, have divers *red* specks up and down where the *Vessels* stand, and their *skin* is accordingly *red*.

The reason, I say of these *Colours*, is the *resolution* or *reformation* of the *Principles* of the several Parts chiefly by the *Air*, and a *lighter mixture* of them consequent thereupon; whereby the *sulphurous* or *oily* parts which were before *concentred*, are now more or less *rampant*, discovering themselves in divers *Colours*, according as they are diversly mixed with the other *Principles*. Hence these *Colours* are observable according to the nature of the Parts *wherein* they are, or whereunto they are *adjacent*; so where

where the *Succiferous Vessels* run, there *red*, or some other more *saturate Colour*; the *oleous Principles* being, as is said, more copious in these *Vessels*; as in the *Bark of Peony*, the inward parts of *Potato's*, &c. may be seen. But the *parenchymous* Parts, where more remote from the said *Vessels*, they are usually *white* or but *yellow*, the *sulphurous Principle* hereof being, as was said, but sparing. The same is seen in those *Roots* which shew both *red* and *yellow*; those parts principally where the *Succiferous Vessels* run being *red*, and where the *Aerial* only mixed with the *parenchymous* being *yellow*, as in *Patience*. So the *pithy* part of a *Carrot*, where the *Aerial* have very few *Succiferous* mixed with them, is *yellow*, but the *Bark* where the *Succiferous* are very numerous, is *red*. For the same reason many *Roots* which are *whiter* in their upper parts, are *purple* or *reddish* in their inferiour, as *Avena*, *Strawberry*, &c. because those lower parts having layn longer under ground (these being *descending Roots*) their *Principles* are thereby somewhat nearer to corruption or somewhat more *resolved*, and so the *oleous ramp* and spread all over the rest in that *Colour*.

And that the *resolution* of the *sulphurous* and other *Principles* is partly effected by the *Air*, appears, in that where the *Air* hath

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a better access to the *Succiferous Vessels*, the *Colours* are chiefly produced, or are more conspicuous. So in *Potato's*, where the *Succiferous Vessels* are either next to the external *Air*, as in the *Skin*; or contiguous with the *Air-vessels*, as in the *Ring* within the *Bark*; there they produce a *red*; but where more remote from both, as in the middle of the *Bark* and Centre of the *Root*, there they produce none. Hence also it is, that the *Leaves* and *Flowers* of some *Plants*, as *Bloodwort*, *Wood-sorrel*, *Radiſh*, *Jacea*, &c. although green or white in the greatest portion of their parenchymous Part, yet where the *Succiferous* and *Aerial Vessels* run, they are of *red*, *blue*, and other *Colours*; the *oleous* parts of the *one* being unlocked and opened by the *aery* of the *other*.

And lastly of their *Tastes*. Where either the *Succiferous Vessels* are *Lymphaducts*, or the *diametral Portions* in the *Bark* are wanting, or the *Air-vessels* numerous and large, the *Root* is of a weaker *Taste*; as that of *Burnet*, *Melilot*, *Borage*, *Bugloſs*, *Cumſry*, *Potato*, &c. For in that they are less *oleous*, and the *Air* more copiously mixed with the *Saline Principles*, whereby these are either *mollified* or *refracted*; they are neither *hot* nor *pungent*, but become more *mild*. Whence also of the same kind of *Roots*, those which have

have the smallest and fewest *diametral portions*, as *Skirrets*, are the *mildest*; and those with the largest, the *strongest*, as *Lovage*.

Most *Roots* which are *acres* or *biting*, have a very copious *Parenchyma* in proportion with the *succiferous Vessels*, as of *Arum*, *Dragon*; and others; because the *saline* and other *Principles* are not so much *bot* by any sufficient quantity of *sulphurous* from those *Vessels*, but rendered rather *pungent* from some *Spirit* and *Air*. But divers *Umbelliferous Roots*, especially which abound with *Lactiferous Vessels*, are *hot*; as *Fenil*, *Lovage*, *Anagelica*, &c. Yet is it not their *Oyl* alone that makes them *bot*, but the combination thereof with the *saline* Parts; as is manifest from the nature of the *Seed* of these *Plants*, wherein the *Oyl* is most copious; and which being held to a Candle till they burn, constantly spit; which cometh to pass by the eruption of the *saline* Parts; being the very same effect with that which followeth upon burning of *Serum* or *Blood*. And therefore as the *Seeds* are more *hot*, they also spit the more, as in *Cumine*, &c. which though fulsom, yet not so *bot*, less; in *Fenil* and *Dill* more; *scil.* there being a greater quantity of *volatile Salt* contained therein. Hence all *essential Oyls* are *bot*, the *Spirit* and *volatile Salt* being incorporated herewith.

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with. And some of them will shoot, and crystallize as *Salts* do, as that of *Anise*, which argues a mixture of a considerable quantity of *volatile Salt*. As also from the nature of these *Oyls*, in being amicable to the *Stomach*, *Carminative*, and sometimes *Anodyne*; *Scil.* as they kill some *fetid*, *corrosive*, or fermenting *Acid*: and *volatile Salts* themselves will have the like operation in some cases as these *Oyls*.

Many *Lactiferous Roots*, as *Teraxicum* and others of that kind, are not so much *hot* as *bitter*. For although by the *Lactiferous Vessels* they are very *oily*; yet those *Vessels* being posited in *Rings* and not in *Rays*, and having no *Diametral portions* running through their *Bark* to the *Air-vessels*; the *Acido-Aerial* parts do hereby, although not *morbose*, yet so far *restrain* the *Saline*, lightly *binding up* the *oleous* therewith, as to produce a *bitter taste*. Which bordereth upon *astringent*; wherein, I suppose, the *saline* and *earthy* are mean, the *oleous* least, and the *acid* most, and so more closely *binding up* the *oleous* and *earthy* with the *saline*. Hence many *sweet* Bodies upon burning become *bitter*; the *acid* Parts, which before were more *concentred*, now becoming *run-pant* and more copiously mixed with the *oleous*.

The

The *Roots* or other parts of many *Umbelliferous Plants* have a *sweetish Taste*, as both *sweet* and *common-Chervil*, both *Garden* and *wild Carrot*, *Parsnep*, *Fenil*, &c. the *Saline Principles* being *concentred* in the *oily*, and both of a moderate quantity with respect to the rest: for by the *oily* the *Saline* is rendred more *smooth* and amicable, and both being moderate, they are not therefore *hot*, as in some other *Umbelliferous Roots*; but by the predominion of the other *Principles* made *mild*. Hence it is, that *Sugar* it self is *sweet*, *scil.* because it is an *oleous Salt*; as is manifest from its being highly *inflammable*; its easie *dissolution* by a moderate *Fire* without the addition of *Water*; and in that being melted with *Turpentine* and other *oily Bodies*, it will *mix* together with them. And the *Crystals* in the *Oyl* of *Aniseeds*, may be called *Saccharum Anisi*. So also the *acid* parts of *Vinegar* being *concentred* in the *Salino-sulphurions* of *Lead* produce a *Sugar*. Hence *Barley*, which upon *Distillation* or *Decoction* yieldeth only an *acid*, being turned into *Mault* becomes *sweet*: *scil.* because being *steeped*, *couch'd*, and so *fermented*, the *oleous* parts are thereby *unlocked*, and becoming *rampant* over the other *Principles* gives them that *Taste*. And the *Bile* it self, which, next to *Water* and *Earth*, consisteth

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consisteth of most *oily* parts, and of many both *saline* and *acid*, is a *bitter-sweet*; the *saline* and *acid* being *smoothed* by the *oleous*, and the *oleous* gently *bound up* together with both those.

THE



THE
EXPLICATION
OF THE
FIGURES.

TABLE I.

FIG. I. *A slice of the Root of Marsh-mallow cut traversely about the top.*

aaa. *The Skin.*

aaa ccc. *The Bark.*

acacac. *Diametral Portions of the parenchymous Body which run through the Bark towards the Centre.*

The black Rings in the Bark represent the position of the Succiferous Vessels.

The black Specks represent the position of the Air-vessels.

The greater whereof are those in the Centre, and

L

The Expication

and the utmost standing in a Ring adjacent to ccc or the inner Verge of the Bark.

N. B. That in this, and all the other Figures generally, by every single Speck is not represented a single Air-vessel, but a Conjugation of Air-vessels, sometimes fewer, and sometimes more together.

Fig. 2. A Slice of the same Root cut transversely about the bottom; wherein both the Succiferous and Air-vessels still keep their general position; but the former are not here represented.

Fig. 3. A Slice of the same Root cut transversely about the middle.

aaa ccc. The Bark; wherein the Diametral Portions and the Succiferous Vessels are both omitted.

cccccc. Diametral Portions frequently running betwixt the Centre and the inner Verge of the Bark in just six Rays.

Fig. 4. A Slice of the Root of Cumfry.

aaa ccc. The Bark.

ccc. The position of the Succiferous Vessels; being from the utmost Verge of the Bark to the black Chords peripherial, and from these the inner Verge standing in Columns.

cccc. The simply Parenchymous parts of the Bark.

cctt.

of the Figures.

cctt. The position of the utmost Air-vessels in double Speck Rays.
tte. The position of the inner Air-vessels in Rings.

All the white Spaces are simply Parenchymous parts of the same Substantial nature with the Pitt.

Fig. 5. A Slice of the Root of Fenil.
aaacc. The Bark, or all that part of the Root which is analogous to it.

cecb. The position of the succiferous Vessels especially called the Lymphæducts in a triple Order of Rays.

eee bbb. The position of the Milk Vessels in Speck Rings.

The white Lines are Parenchymous portions running through the Bark.

cccc. The Air-vessels, somewhat radiated.
c. The Pitt.

Fig. 6. A Slice of the Root of Parsnep.

aaa eee. The Bark.

eee. The position of the succiferous Vessels in Rays.

eee c. The Air-vessels, more plainly radiated about the circumference, and more confused about the Centre.

Fig. 7. A Slice of the Root of Beet.

L 2

aaa.

The Explication

aaa. The Skin.

To the first Order of Specks may be accounted the Bark, and no further.

eee ccc. The Succiferous Vessels postured in Rings, and those Rings made up of short Rays.

The Specks are the Air-vessels, being all postured from the Centre to the Circumference in Speck Rings, and those Rings made up of short Rays; especially those betwixt aaa tt. The white Spaces are all Parenchymous parts.

Fig. 8. A Slice of the Root of Horse-Radish.

aaa ccc. The Bark.

The Specks therein represent the position of the Succiferous Vessels.

ccc vvv. The Air-vessels, standing neither in Rays, nor Rings.

c. The Pith.

The Specks therein are a few of the Succiferous Vessels.

Fig. 9. A Slice of the Root of Borage.

aaa ccc. The Bark.

The Succiferous Vessels are here omitted, but are postured in Rays like those in Fig. 30.

cccc. The Air-vessels.

cece. Their position more in Rays next the inner Verge of the Bark.

eee. Their position in Spiral lines next the Centre.

of the Figures.

The white spaces are simply parenchymous parts.

Fig. 10. A Slice of the Root of Peony.

aaa ccc. The Bark.

The Specks therein represent the position of the Succiferous Vessels.

ccc. The greater part of the Air-vessels pos-
sured in a Ring next to the inner Verge of
the Bark; and that Ring made up of short
Rays; and most of the Vessels herein of a
larger size.

At the Centre also there are one or two Con-
jugations more of a larger size.

The rest standing in Rays betwixt are smaller
and more distant.

All the white Spaces are simply Parenchymous
parts.

Fig. 11. A Slice of the same Root cut tra-
versely about the thinner part.

aaa ccc. The Bark.

The Specks therein represent the Succiferous
Vessels.

ccc. The smaller Air-vessels posured in Rays.
The greater standing here only next the Centre,
and posured triangularly.

Fig. 12. A Slice of the thick level Root of
Iris tuberosa.

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The Explication

aaa ccc. *The Bark.*

Upon the inner Verge hereof stand the Succiferous Vessels; but are here omitted.

ccc. *The Air-vessels; somewhat closer here than they are in the Root it self.*

ccc. *Other Air-vessels dispersed up and down in several Conjugations irregularly.*

The Air-vessels of every Conjugation are posited in a little Ring, each Ring or Conjugation containing a part of the parenchymous Body as a small Pith within it self, represented by the black Specks.

Each one of these Conjugations shooting forth entire with its Pith within, and part of the Parenchyma without, becomes a perpendicular String-Root, like that represented by Fig. 27.

Fig. 13. *A Slice of the Root of Bistort.*

aaa ccc. *The Bark.*

Upon the inner Verge of the Bark stand the Succiferous Vessels in a Ring; but are here omitted.

ccc ccc. *The Air-vessels all posited in a Speck Ring next the inner Verge of the Bark, ccc. The Pith.*

Fig. 14. *A Slice of the Root of great Celadine.*

aaa ccc. *The Bark,*

The

of the Figures.

The peripheral Lines or Chords, represent the position of the Succiferous Vessels.

ccc. The Air vessels postured all in Rays from the inner Verge of the Bark towards the Centre.

About the Centre more confusedly.

cc. The parenchymous or pithy parts.

Fig. 15. A Slice of the Root of Dandelion.

aaa ccc. The Bark; or all that part of the Root which is analogous to it.

The peripheral Lines, or Rings and Chords represent the position of the Succiferous or Milk vessels.

ccc. The Air-vessels postured confusedly.

c. The Pith.

Fig. 16. A Slice of the Root of Columbine.

aaa ccc. The Bark,

The Succiferous Vessels herein postured rather in Rays; though the Graver hath represented them by Rings.

ccc. The Air vessels postured in Rays; Some whereof are continued to the Centre, others half way, or less.

The white Spaces represent the parenchymous parts.

Fig. 17. A Slice of the Root of Orpine cut transversely at the tuberosus part.

L 4

aaa

The Explication

aaa ccc. The Bark.

The small Specks represent the position and quantity of the Succiferous Vessels therein.

ccc ccc. The Air-vessels.

ccc. The utmost of them postured in a Ring.

ccc. Divers of them running from the Ring in Rays towards the Centre.

The white Spaces analogous to the Pith.

Fig. 18. A Slice of the same Root cut transversely at the slender part.

Wherein the Air-vessels are postured in a double Ring, the one next the Bark, the other next the Centre.

Fig. 19. A Slice of the Root of Goats-beard.

aaa ccc. The Bark.

ccc. One part of the Succiferous or Milk Vessels postured in a Ring upon the inner Verge of the Bark.

And some of them which should have been represented by prickles sprinkled up and down the Bark are omitted.

cccc. The Air-vessels all postured in Rays, and running from the inner Verge of the Bark towards the Centre.

And a Conjugation of them postured just in the Centre.

Between these Rays of Air-vessels run some exceeding small Diametral and more aery
-tions,

of the Figures.

portions of the parenchymous Body.

Fig. 20. A Slice of the Root of Valerian.

aaa ccc. The Bark.

ccc. The Succiferous Vessels postured in a Ring upon the inner Verge of the Bark.

The Specks represent the Air-vessels postured likewise in a Ring next the inner Verge of the Bark; and some of them radiated towards the Centre.

x. The Pith.

Fig. 21. A Slice of the thicker part of the level Root of Ammi.

The smaller Specks represent the position and quantity of the Succiferous or Milk-vessels in the Bark.

The larger Specks represent the Air-vessels postured in a Ring adjacent to it; and usually made up of nine Conjugations. Within is contained the Pith.

Fig. 22. A Slice of the thinner part of the same level Root.

The Succiferous Vessels in the Bark are omitted.

The Air-vessels postured in a Ring adjacent to it; and consisting of five Conjugations.

Fig. 23. A Slice of the perpendicular Root of Ammi.

The

The Explication

The smaller Specks are the Succiferous Vessels in the Bark, or that part of the Root analogous to it.

The great black Spot representeth the Air-vessels all conjugated or clustered in the Centre.

Fig. 24. *A Slice of the upper part of the Root of Venus Looking-glass.*

aa cc. The Bark,

cc. Some of the Succiferous Vessels postured therein in a Speck Ring.

cc cc. And some of them postured in Rays.

cc. The Air-vessels; some of them postured in single Conjugations next the Bark, but most in Rays meeting in the Centre.

The white Spaces are parenchymous parts.

Fig. 25. *A Slice of the thinner part of the same Root.*

Wherein the Succiferous Vessels are in part postured into three Chords answerable to the former in a Circle.

The rest should have been in short Rays.

The Air-vessels are postured in three portions triangularly; and each portion also of a wedged or triangular Figure; the points of all three meeting in the Centre.

Fig. 26. *A Slice of the Root of Sun Spurge. Wherein the Air-vessels are postured in four Conjugations quadrangularly.* **Fig.**

of the Figures.

Fig. 27. *A slice of the perpendicular or String-Root of Asparagus.*

aaa. *The Skin, which is very thick.*

aaa xx. *The Bark; or all that part of the Root which is analogous to it.*

The small black Rings represent the position of the Succiferous Vessels upon the inner Verge of the Bark; yet not in two Rings as here represented, but in one.

The inner white Space representeth the position of the Air-vessels in a thick Ring.

The black spot representeth the small Pitb within it.

Fig. 28. *A slice of the tuberous or thicker part of the Root of Lilium non bulbosum.*

aaa ccc. *The Bark; or all that part of the Root which is analogous to it.*

The Succiferous Vessels are postured in a Ring upon the inner Verge of the Bark, as in Asparagus, but here omitted.

ccc. *The Air-vessels postured in a thin speck Ring.*

c. *The Pitb.*

Fig. 29. *A slice of the Root of Jerusalem Artichoke.*

aaa. *The Skin.*

ccc. *The Bark.*

The Succiferous vessels therein dispersed up and

The Explication

and down chiefly in Specks, and some in shorter Chords, but both are here omitted; and the rest in a Ring upon the inner Verge of the Bark.

cccc. Divers other Succiferous Vessels dispersed abroad about the Centre; but the Conjugations are smaller and less discernable than is represented by these Specks.

ddd. The Air-vessels postured in Rays of unequal length, and winding to and fro towards the Centre.

With each of these Rays other Succiferous Vessels seem to be mixed.

All the white Spaces are simply parenchymous and of the same nature with the Pith.

Fig. 30. A Slice of the Root of Bugloss.
aaa ccc. The Bark.

ccc ccc. The Succiferous Vessels therein postured in Rays, and running from the inner Verge thereof towards the Circumference about half way.

ccc t. The Air-vessels postured in Rays, and running directly from the inner Verge of the Bark towards the Centre.

q c t. Parenchymous Portions inserted betwixt all the Rays, and meeting in the Centre.

Fig. 31. A slice of a younger Root of Eryngo.

of the Figures.

aaa ecc. The Bark; or all that part of the Root analogous to it.
 ecc ecc. The Succiferous Vessels.
 ecc. Those upon the inner Verge of the Bark posited in a Ring.
 ecc ecc. Others streaming in Rays towards the Circumference.
 ecc. The uniting and oval or arched termination of the Rays.
 ecc v. The Air-vessels posited in a Ring adjacent to the inner Verge of the Bark.
 v. The Pith.

Fig. 32. A Slice of the Root of Brownwort.

aaa ecc. The Bark.
 ecc. The Succiferous Vessels posited in a Ring upon the inner Verge thereof.
 ecc ecc. The Air-vessels posited in Rays from the inner Verge towards the Centre.
 ecc. The same Air-vessels standing thicker and altogether confusedly at the Centre.

Fig. 33. A Slice of the Root of Nettle.

aaa ecc. The Bark.
 ecc. Those Succiferous Vessels that are therein posited in a Ring upon the inner Verge thereof.
 All the rest of the Succiferous Vessels are posited in divers other Rings standing all one within another.

The Explication

The Air-vessels are postured in Rays running directly cross the Succiferous Rings.

Fig. 34. *A Slice of the tuberos or thicker part of the Root of Dropwort.*

aaa ccc. *The Bark.*

ccc. *The Succiferous Vessels postured in a Ring.*
 cccc. *The Air-vessels postured some in single*

Conjugations adjacent to the inner Verge of the Bark; and some in Rays meeting in the Centre.

Fig. 35. *A Slice of one of the thinner and rounder parts of the Root of Bryony.*

aaa ccc. *The Bark.*

cccc. *The Succiferous Vessels postured therein in the form of a Glory, and extended about half way towards the Circumference of the Bark.*

cccc. *The Air-vessels postured partly in Rays, but especially in Rings one within another from the inner Verge of the Bark to the Centre.*

Round about every Speck or Conjugation Succiferous Vessels also seem to stand.

All the white Spaces are simply parenchymous parts.

Fig. 23. *A Slice of the Root of Melilot.*

aaa ccc. *The Bark.*

The Specks represent the position of the Succiferous Vessels therein,

of the Figures.

The Diametral Portions extended half way towards the Circumference of the Bark are here omitted.

ccc. Three very thick Parenchymous or Diametral Portions, posured triangularly, and meeting in the Centre.

The Air-vessels are all posured in Rays represented by the Prick-lines.

Both these and the smaller Diametral Portions running betwixt them should have been more numerous.

Fig. 37. A Slice of the Root of Burnet.

aaa eee. The Bark.

eee. The position of the Succiferous Vessels in Columns extended half way towards the Circumference.

Divers other Succiferous Vessels posured in Chords represented by the black Lines.

All the white Spaces are simply Parenchymous parts.

The Air-vessels are posited in Rays from the inner Verge of the Bark to the Centre.

Fig. 38. A Slice of the upper part of the Root of Lovage.

aaa ccc. The Bark.

The black Lines are the Diametral Portions running through the same from the Circumference towards the Centre: within the Bark

The Explication

Bark very conspicuous, but out of it scarce discernable.
 The little Circles and Specks represent the Succiferous Vessels posited betwixt the Diametral Portions, some of the Circles on both sides adjoining to the said Portions.
 bbb. The more succulent Parenchymous parts of the Bark wherein all the Succiferous Vessels stand.
 ccc. The Air-vessels standing most of them in short Rays from the inner Verge of the Bark towards the Centre, and some of them meeting therein.
 d. The Pith.

Fig. 39. A slice of the smaller part of the same Root.

aaa ccc. The Bark; or all that part of the Root which is analogous to it.
 From ccc to the Centre stand the Air-vessels all contracted together.

Fig. 40. A slice of the Root of Patience.

aaa ccc. The Bark.
 ccc. The simply Parenchymous part of the Bark.
 ccc. The Succiferous Vessels posited in Rays, and extended from the inner Verge of the Bark both towards the Circumference and towards the Centre; most of them in the Bark

of the Figures.

Bark uniting or arching together.

III. Other Succiferous Vessels, many of them winding to and fro in extravagant lines, but most of them posured in little Circles of different Sizes, all represented by the Specks. Within every Circle, and the larger white Spaces, are contained the Air-vessels; but not here represented, because, being few, not discernable, except by Glasses. All the other parts of the white Spaces besides where the Air-vessels stand, are simply Parenchymous.

Fig. 41. A Slice of a small Potato.

aaa bbb. The Bark.

The Succiferous Vessels are posured therein some in Rays and Specks upon the inner Verge, and others in Chords towards the circumference; whereof some of them should have been longer.

bbb. And the other shorter Lines and Specks towards the Centre, are the Air-vessels.

cccc. The simply Parenchymous parts.

Fig. 42. A Slice of a Carrot.

aaa ccc. The Bark.

The position of the Succiferous Vessels therein is represented both by the Lines and Specks. Their position in short Lines upon the inner Verge of the Bark,

M

cbcbcb

The Explication

cbcbcb. *Their position in Speck Rays extended towards the circumference.*

bbb. *Their position in winding lines partly radiated, and partly peripheral: more of which should have been represented adjacent to the Skin, and running sharper and more directly upon the Speck Rays.*

ccc. *The position of the Air-vessels in short Rays from the inner Verge of the Bark towards the Centre.*

Divers other Air-vessels sprinkled up and down the pithy part of the Root, represented by the black Specks; and seeming to be environed with other Succiferous Vessels.

NB. *That besides the differences betwixt these Roots seen in their Descriptions here set down; divers others may be observed by comparing the Figures together: and many more in viewing them through a Microscope; especially as to the number and size of the Vessels, and of the Bubbles of the Parenchymous parts.*

Though most of the Figures come up to what is material, yet some of them fall short of that elegance and preciseness visible in the Roots themselves, if cut and observed in a due manner.

TABLE

of the Figures.

T A B L E II.

Fig. 1. *A piece of the Root of Scorzonera split down the middle.*

aaaa. *The Skin or outside of the Bark; which is very rough.*

cece. *The Conjugations of the Succiferous or Milk-vessels, by which partly the skin becomes rough.*

ccc. *The Braces of the said Vessels.*

eee. *The Parenchymous parts filling up the spaces betwixt the braced Vessels.*

aaa ttt. *The Bark shewed in the transverse cut.*

The Specks represent the position of the said Milk-vessels therein.

tdtdtd. *The Air-vessels postured in Rays.*

d. *A larger Conjugation of them in the Centre.*

Fig. 2. *A piece of the Bark of the Root of Garden Burnet; which stripeth off much better than that of Scorzonera.*

aaaa. *The inside thereof represented and laid flat.*

The black Lines represent the position of the Succiferous Vessels.

At the white Spaces they are divaricated by their Braces.

The Explication

Fig. 3. *A piece of the same Scorzonera Root before in part described.*

aaaa. Representeth the middle part or Substance of the Bark, the outward part being paired off.

cece ce. The above said Milk-vessels.

cccc. Their Braces here towards the inner Verge of the Bark more numerous.

cccc. The Parenchymous parts filling up the Spaces betwixt the braced Vessels.

Fig. 4. *A piece of the Root of Dandelion split down the middle.*

ac ac. The thickness of the Bark, or all that part of the Root analogous to it.

ssss. The Conjugations of the Milk-vessels running through it: which should not have been represented by Lines altogether continuous, but frequently broken off (as those in the Bark of Burnet) where they are divided by their Braces.

acced. The said Milk-vessels as they appear postured in Chords and Rings upon the transverse cut.

ccc. The Air-vessels all clustered together in the Centre.

Fig. 5. *A piece of the same Scorzonera Root before in part described.*

aaaa. Representeth it with the Bark striped off

of the Figures.

off by half its circumference.
eded. The Air-vessels adjacent to the inner
verge of the Bark.
ddd. The Braces of the Air-vessels conforma-
ble to the utmost Braces of the Milk-vessels
represented in Fig. I. of this Table.
eee. The Parenchymous parts filling up the
spaces betwixt the braced Air-vessels.
ccce. The Air-vessels appearing in the transverse
cut, as in Fig. I. of this Table.
The Lines should have run directly upon the
Specks; the Specks being the terminations
of the said Lines or Air-vessels running
through the length of the Root from the in-
ner Verge of the Bark to the Centre.

Fig. 6. A piece of the same Scorzonera Root
split down the middle, as the first.

aaaa. Representeth the inside or the flat of the
said piece.

deded. The Air-vessels running through it
betwixt the inner Verge of the Bark and the
Centre.

vvv. The breaking off of the said Vessels
where they are divaricated by their Braces.
ceee. A larger Conjugation or Cluster of the
said Vessels at the Centre, and there more
closely braced.

ca ba. The Bark and the Milk-vessels therein
appearing upon the transverse cut.

M 3

ce.

The Explication

c.e. The Air-vessels.

Fig. 7. A slice of the Root of Borage cut down the middle.

aa cc. The thickness of the Bark,

cccc. The Air-vessels represented by all the broken Lines.

cc. Most of the said Vessels more frequently braced towards the inner Verge of the Bark, being broken or cut off at every Brace.

cccc. Some few of them braced more closely at the Centre; and many of the Braces appearing together unbroken.

edc. The gradual approach of the said Vessels towards the circumference at the top of the Root.

d. The Pith thereby made.

Fig. 8. A slice of a Carrot cut down the middle.

ad ad. The thickness of the Bark,

dbb dbb. The Air-vessels running through the Root.

db. Their closer position, more frequent Braces, and greater number next the inner Verge of the Bark.

The rest about the middle and Centre represented by the smaller Lines: the greater should have been so many light shades representing the more sappy parts of the Parenchymous

of the Figures.

renchymous or pithy body where some few of the Succiferous Vessels seem to run.

One or two Conjugations should also have been drawn from d to e at the top, bounding the Pith in an Hyperbolical Figure.

cccc. Some of the Succiferous Vessels gathered together more numerously at the top of the Root, without any Air-vessels mixed with them.

cccc. The Side-leaves.

ae. The Centre-leaves springing up either before or upon the Caulis.

de. The Space wherein some both of the Succiferous and Air-vessels are, by degrees, collaterally distributed into the said Leaves

cc a e.

Fig. 9. A Slice of the Root of Parsly cut down the middle.

ad ad. The thickness of the Bark.

vv. The Air-vessels: but the Lines by which they are represented should not have been altogether continuous, as they are, below the oval, nor all out so numerous.

ve ve. The Conjugations of the said Vessels running along the circumference, and meeting at the Basis of the Caulis, and so bounding the Pith in an oval Figure.

ca ca. The Side-leaves.

cc. The Centre-leaves.

M 4

stle.

The Explication

st l. *Some of the Succiferous Vessels standing in the Pith without any Air-vessels mixed with them.*

s vv. *Some of them more numerous and confused.*

tt ll. *Others of them arched.*

ll c. *The Arches closer and more obtuse.*

In the transverse cut of the Root the same Succiferous Vessels appear postured in Rings.

sss. *The Parenchymous parts of the Pith.*

Fig. 10. *A piece of the Root of Jerusalem Artichoke cut by the length.*

aaaa. *As it appeareth with part of the Bark paired off.*

cece. *The Air-vessels.*

cc. *The Braces of the said Vessels, being very rare.*

eecc. *The Succiferous Vessels with their Braces, which are exceeding numerous, and much divaricated.*

The white Spaces are Parenchymous parts.

Fig. 11. *The Root of Jerusalem Artichoke.*

aaa. *As it appeareth with all the Bark paired off.*

bd. *The Air-vessels.*

d. *Their Braces.*

bcd. *The Spaces betwixt them filled up with the Parenchymous body.*

cc ee.

of the Figures.

cc cc. The manner of the eruption of a Root-Bud, or of a Trunk from the Root.

The Rings are made up chiefly of the Succiferous, and the Rays and Specks of the Air-vessels.

c. The Pith in the Centre of the Bud.

TABLE III.

Fig. I. A Slice of one of the perpendicular or String-Roots of Asparagus cut transversely.

aaa. As it appeareth to the bare eye.

The utmost black Ring is the Skin.

ccc. The Bark, or all that part of the Root which is analogous to it.

The inner black Ring sheweth the position of the Succiferous Vessels upon the inner Verge of the Bark.

Within which the Air-vessels stand, and should have been represented by another white Ring.

And within this a very small Pith according to Fig. 27. (Tab. I.) above described.

AA. One half of the same Slice as it appeareth through the Microscope.

bb. The Skin; composed throughout into Bubbles.

It should have been bounded by a Line from the rest of the Bark to the thickness of about one third of an Inch. AA.

The Explication

AA. GG. The Bark, or all that part of the Root analogous to it; composed throughout into Bubles.

ee. The Bubles of the Bark; here more round. The Texture of the fibrous Threds whereof they are composed, is not here represented, because that will be more perspicuous in the draught of the Pith of the Root.

DD. GG. The position of the Succiferous Vessels in a Ring upon the inner Verge of the Bark.

GG. TT. The Air-vessels also postured in a Ring; and of a larger size.

The white Rings shew the sides of the said Air-vessels.

The black Spots within them shew their Concaves.

The Spaces betwixt them filled up with a mixed body, partly consisting of Succiferous Vessels, but chiefly Parenchymous.

TT. The Pith, composed throughout into Bubles.

Fig. 2. A slice of the slender part of the Root of Jerusalem Artichoke cut transversly.

aaa. As it appeareth to the bare eye.

ccc. The Bark.

ce-ce. Both the Succiferous and the Air-vessels represented by the black Lines, the Succiferous

of the Figures.

Succiferous being posured directly against the *Air-vessels*, upon the inner Verge of the Bark. But the Lines are too few.

e. The Pith.

AA. One half of the same Slice as it appears through the Microscope.

bb. The Skin,

AA. EE. The Bark.

The black Columns are the *Succiferous Vessels*.

SS. The younger and more succulent portion of the said Vessels posured in Chords.

In the other parts of the Columns stand the elder and less succulent.

Amongst them stand the *Air-vessels*, of a smaller size, and about four or six in every Column.

EL. EL. Other Columns betwixt them wholly *Parenchymous*.

LL. The Pith.

cc. The Bubbles of the Pith, which are very large, and most of the largest by the Westage of their composing Fibres made angular.

TABLE IV.

Fig. I. A Slice of a smaller Root of *Dandelion* cut traversely.

aa. As it appeared to the bare eye, answerable to Fig. 15. Tab. I.

AA.

The Explication

AA. One half of the same Slice as it appeareth through a Microscope.

CC. The Skin.

AA. GG. The Bark; or all that part of the Root analogous to it.

DTG. The position of the Succiferous or Milk-vessels amongst the smaller Bubbles, in Chord-Rings; the Chords being of different lengths in the same Ring.

EE. The Parenchymous Rings betwixt them, all from C. to G. wherein the Bubbles are of a larger size; yet all of them small in respect of those in many other Roots.

GI. GI. The Bubbles streaming in Rays cross three or four of the black Rings; in which space other Succiferous Vessels, scil. Lymphæducts seem to be mixed with the Læal.

From GG. inward stand the Air-vessels, all contracted into a Cylinder in the Centre: The larger whereof about the Centre, the smaller next the Bark. And all of them small in comparison with those in many other Roots.

The Spaces betwixt them filled up with a mixed body, partly consisting of Succiferous Vessels, but chiefly Parenchymous.

Fig. 2. A Slice of the smaller part of the Root of *Amaranth-mallow* cut transversely.

aa.

of the Figures.

aa. As it appeareth to the bare eye according to the Description of Fig. 2. Tab. I.

AA. One half of the same slice as it appeareth through a Microscope.

bb. The Skin; not altogether so thick; and the Bubbles rather postured in Rays.

DA. DA. The Bark.

GG. The Succiferous Vessels postured in a Ring upon the inner Verge of the Bark.

SS. LL. The rest of the Succiferous Vessels standing in more distinct Conjugations throughout the Bark both in Rings and Rays represented by the black Spots.

SL. SL. The Parenchymous parts of the Bark standing betwixt them.
From DD. to the Centre stand the Air-vessels.

DT. DT. Some few of them postured in Rays: the parts betwixt which are wholly Parenchymous or pithy.

From TT. inward the rest, and greater parts of the Air-vessels standing together in the Centre.

TABLE V.

Fig. 1. A slice of the lower part of the Root of Engloss cut transversly, as it appeareth to the bare eye.

a. The skin.

ac. The Bark.

The Explication

ccc. The Succiferous Vessels in a Ring.
Within them the Air-vessels.

Fig. 2. The same slice, as it appeareth through
a Microscope.

A. bbbb. The skin; which should have been
somewhat thicker.

AA, LL. The Bark.

bb, GG. The Bubbles of the Bark posited ra-
ther circularly.

GG, FF. The rest of the Bubbles all radiated;
amongst which 'tis probable some few of
the Succiferous vessels run.

SS. The arching of the Bubble-Rays.

FF, LL. The Succiferous vessels more visibly
and numerously posited in a Ring upon
the inner verge of the Bark.

Within stand the Air-vessels posited in Rays,
most of them meeting in the Centre.

ttt. A single Air-vessel.

ll. A Conjunction of two in the peripheral
positure.

ff. A Conjunction of three in the Diametral
positure.

ccc. Some of them more firmly contained to-
gether in the Centre by the Parenchymous
Threads.

dddd. Parenchymous parts.

TABLE VI.

Fig. 1. A slice of the lower part of the Root
of

of the Figures.

of Horſe-Radiſh cut tranſverſly, as it appeareth to the bare eye.

- a. The Skin.
- ac. The Bark, with the Succiferous Veſſels therein repreſented by the ſmaller Specks.
- Within ſtand the Air-veſſels repreſented by the larger and blacker Specks.
- e. The Pith.

Fig. 2. The ſame Slice, as it appeareth through a Microſcope.

- AA. The Skin.
- A.B. The Bark.
- B.L. The Succiferous Veſſels therein poſtured in the form of a Glory.
- B.G. The Air-veſſels poſtured in a thick Ring; the ſeveral Conjunctions whereof are radiated.
- G.E. Other Succiferous Veſſels within the Air-veſſels poſtured in a thin Ring.
- E. The Pith.
- ec. The Bubbles of the Pith.

TABLE VII.

Fig. 1. Should have repreſented a Slice of a ſmall Root of a Vine cut tranſverſly; but the Sculpture is utterly falſe.

Fig. 2. The ſame Slice, as it truly appeareth through a Microſcope. A.

The Explication, &c.

A. The Skin.

A.B. The Bark.

S. The Succiferous Vessels therein postured in more distinct Portions, the Figure of each Portion coming near an half-oval.

LLL. The woody part of the Root consisting of Vessels originally succiferous.

Amongst them stand the Air-vessels of different sizes.

ccc. One of the largest.

e. A Conjugation of three small ones.

DD. Parenchymous or Diametral Portions inserted betwixt the aforesaid Vessels about a third part towards the Centre; the Bubbles whereof are quadrilateral.

B.G. Other larger and longer Portions continuous with the Bark, and pointing near the Centre.

B.L. Six others all meeting in the Centre, and crossing each other almost at equal Angles.

FINIS.

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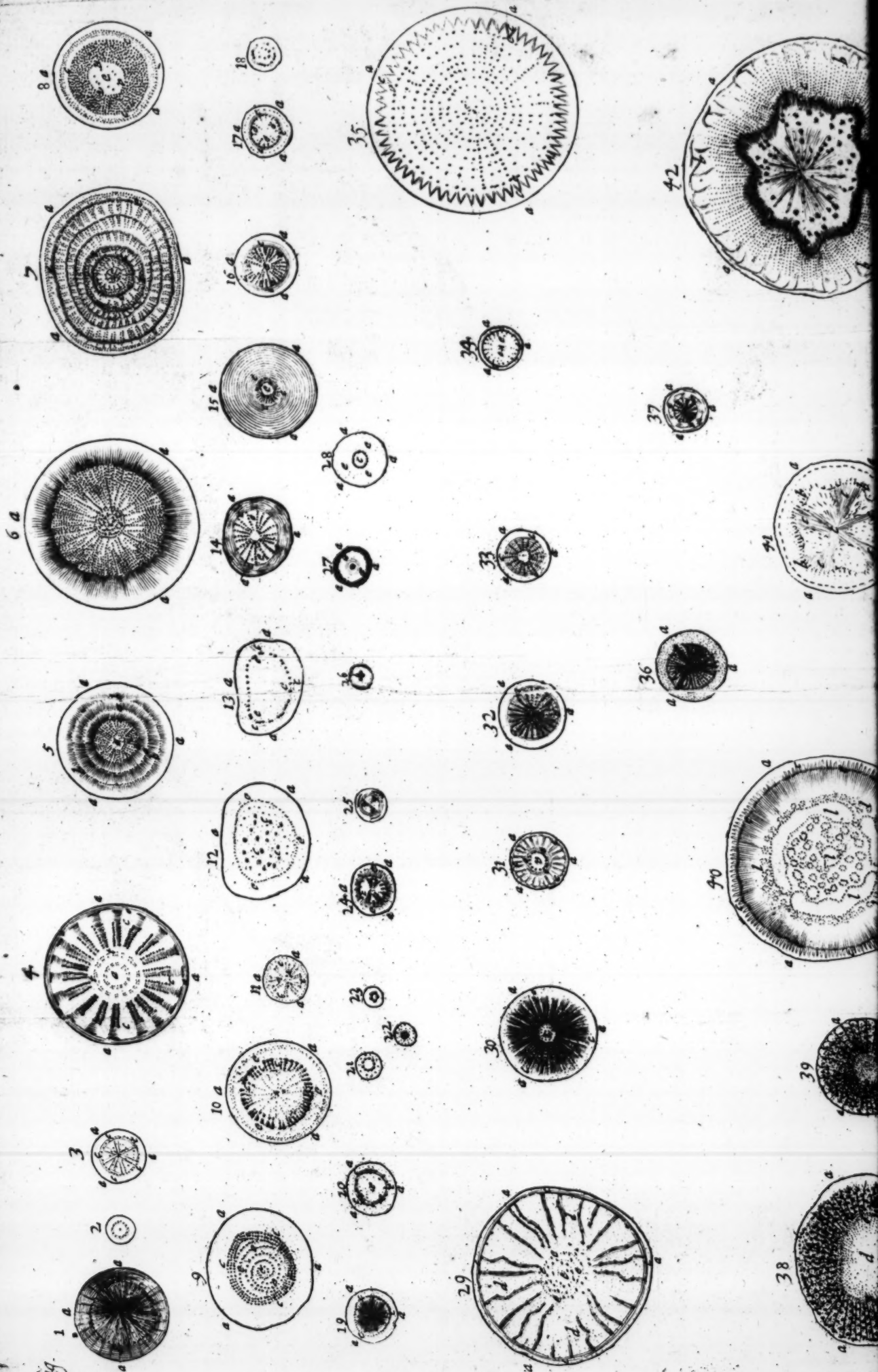
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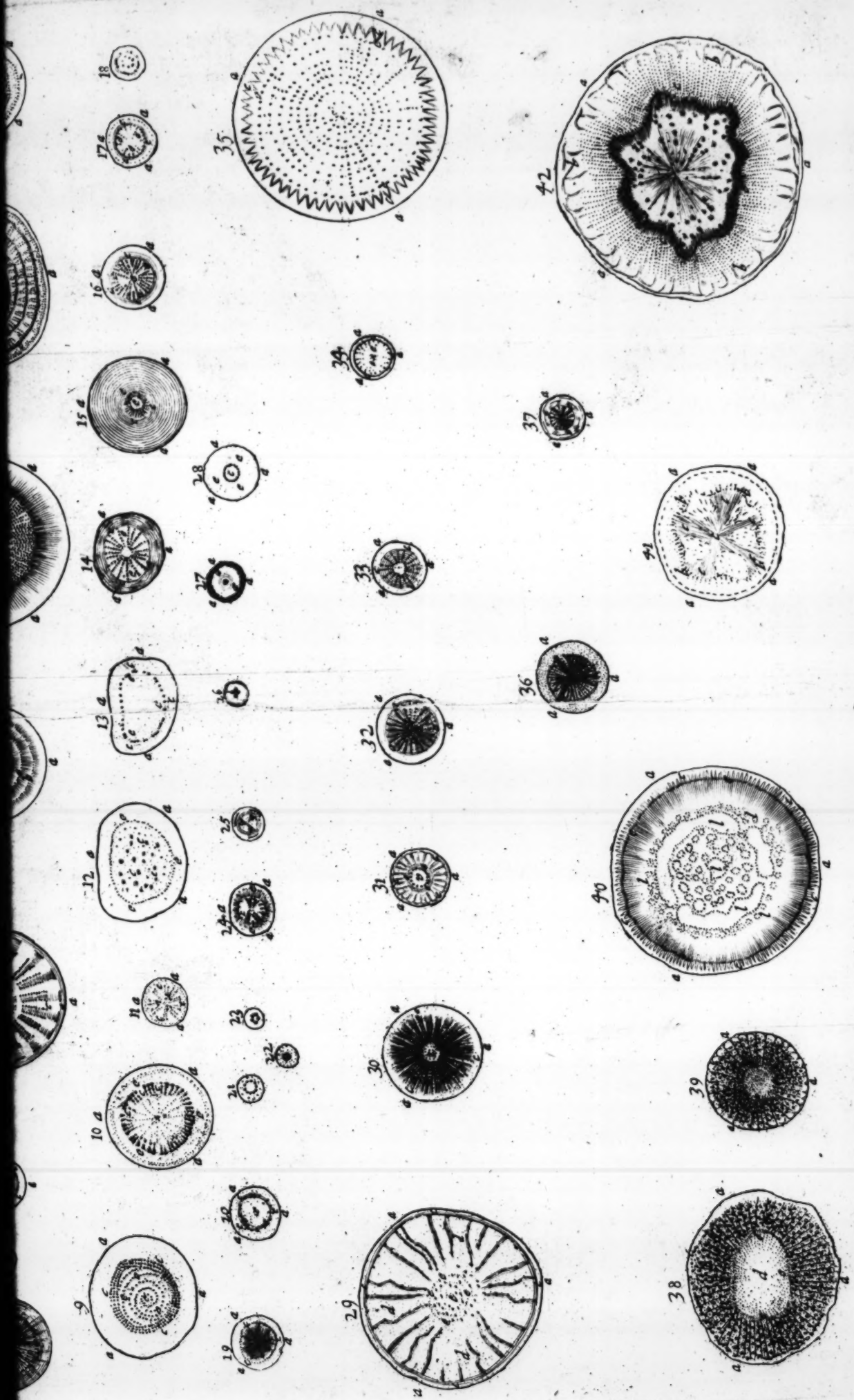
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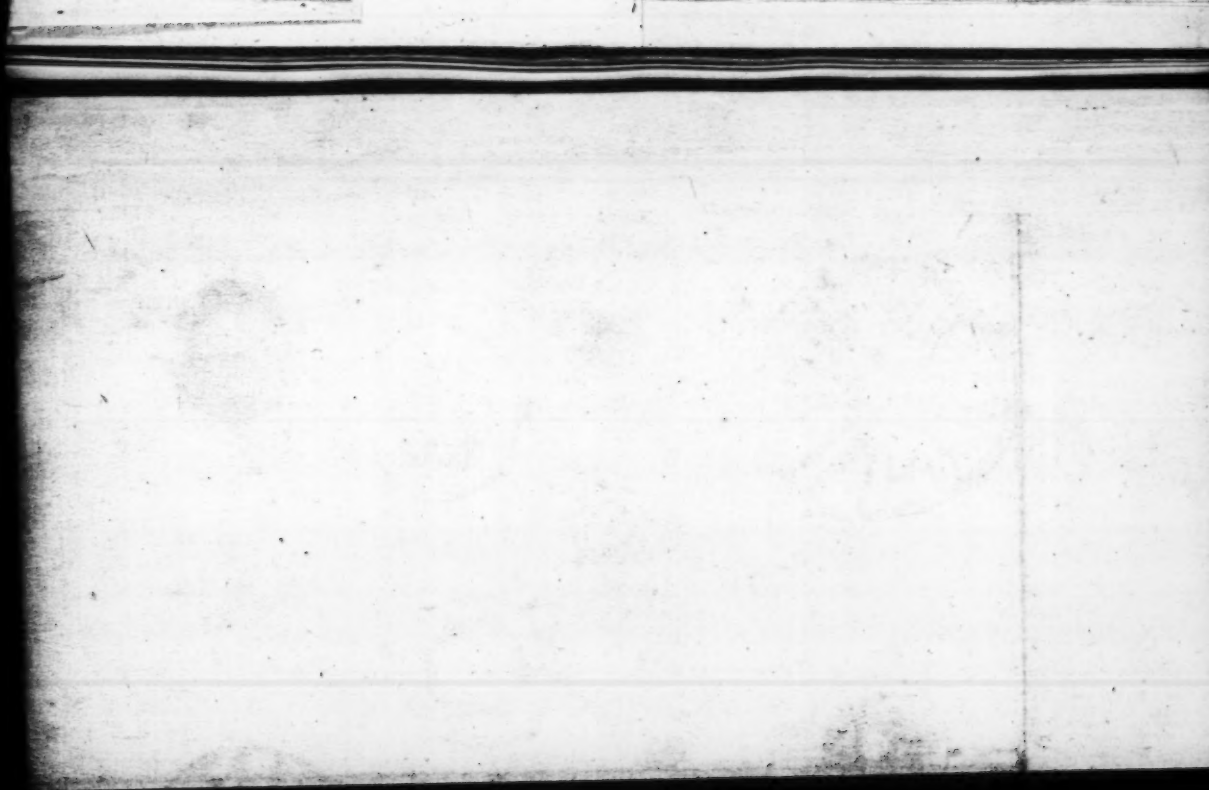
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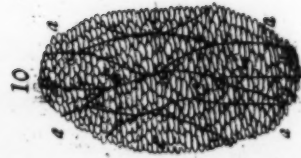
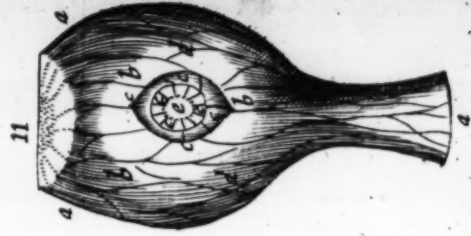
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Fig.









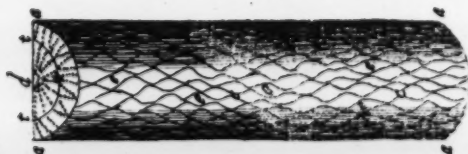
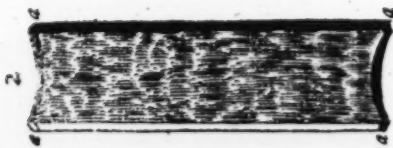
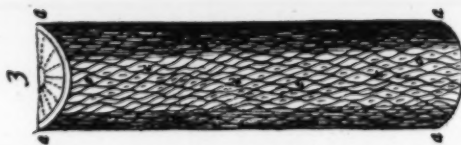
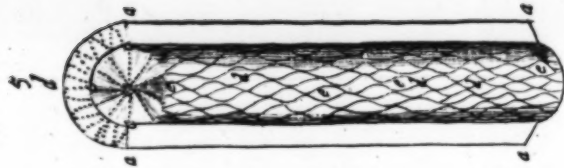
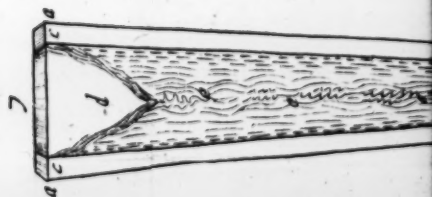
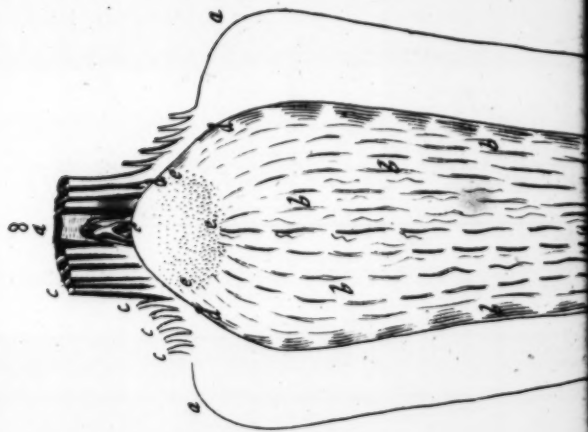
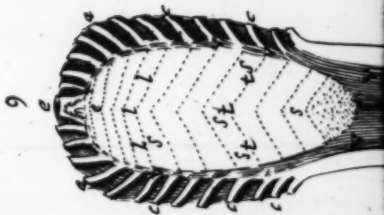
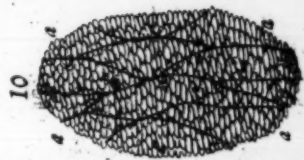
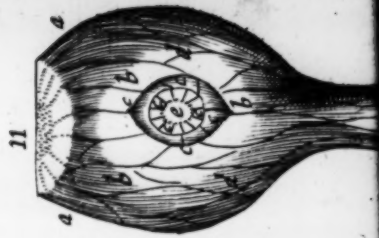
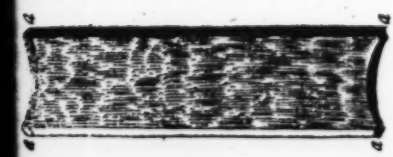
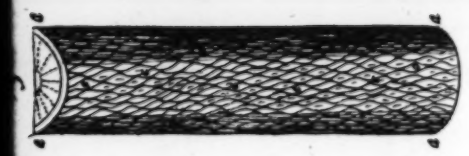
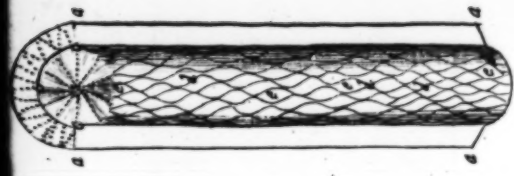
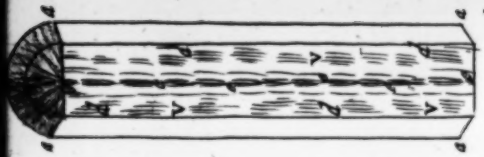
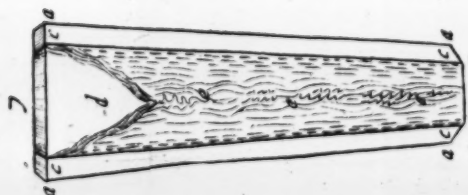
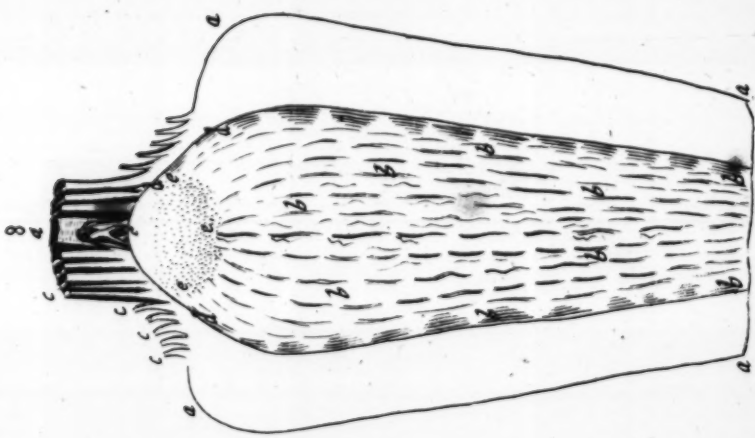
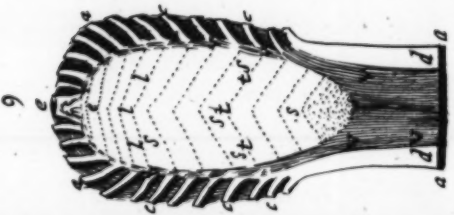
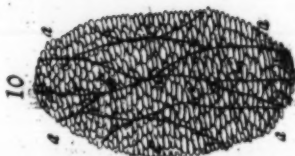
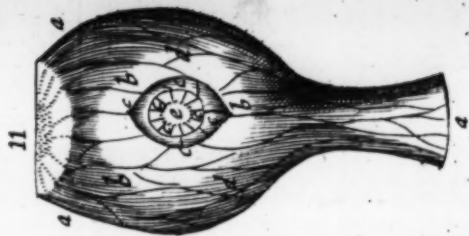
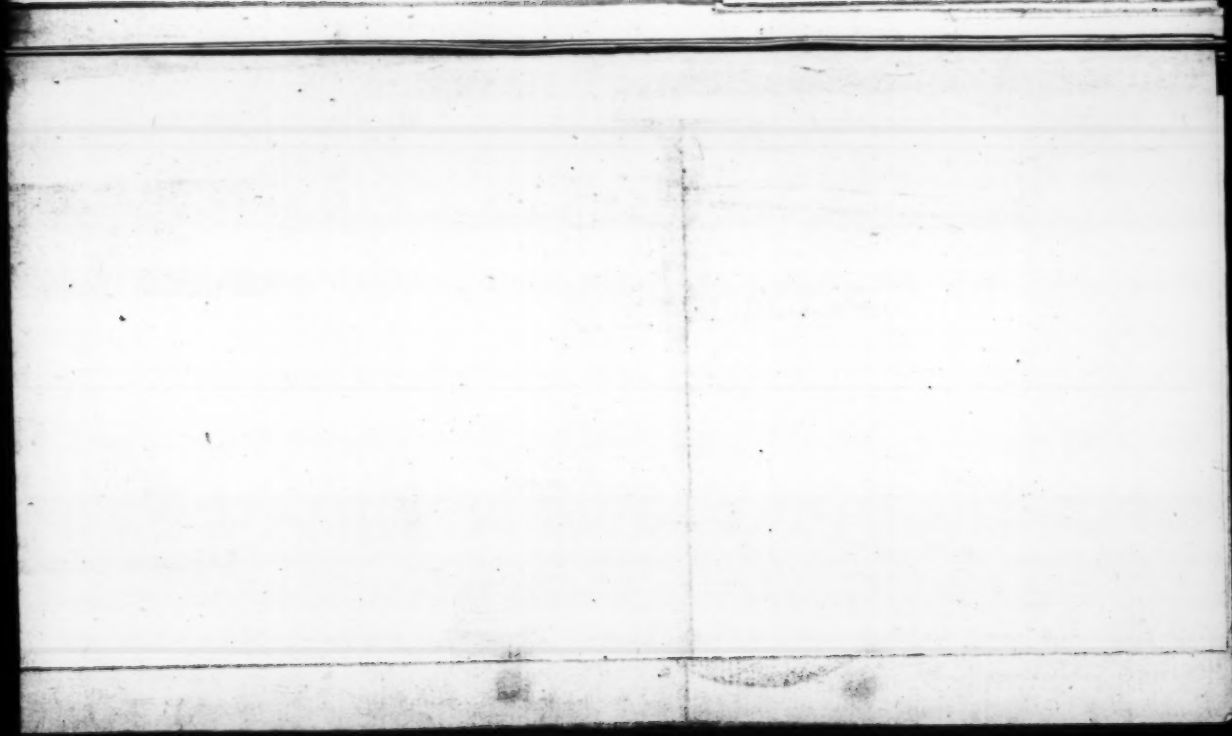


Fig. 1.







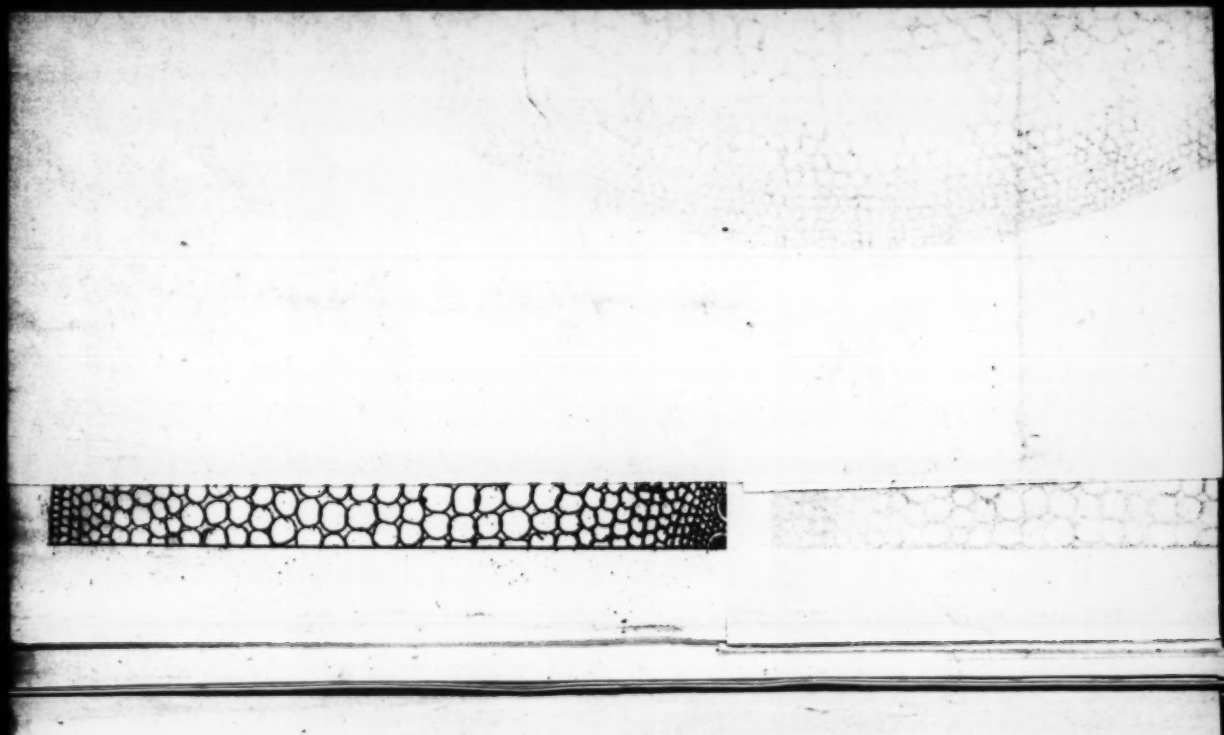


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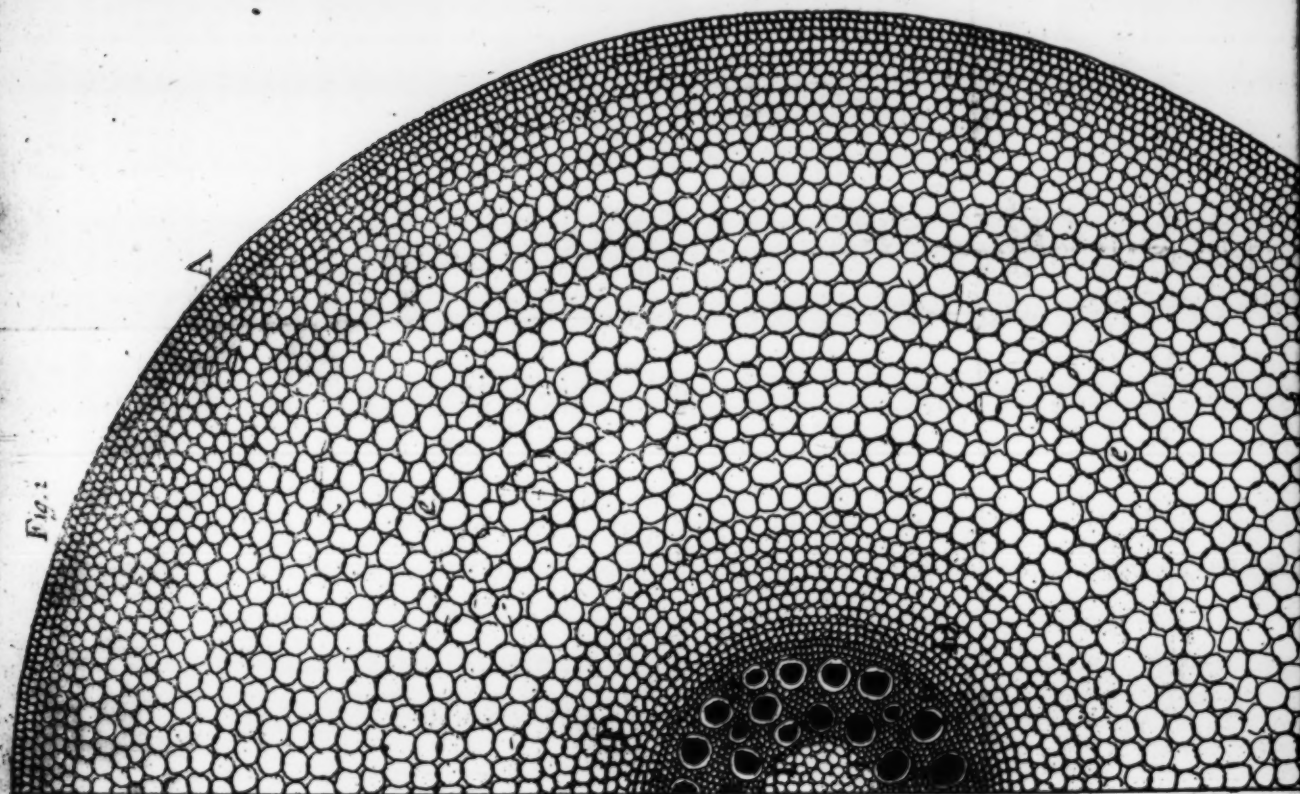


Fig 2

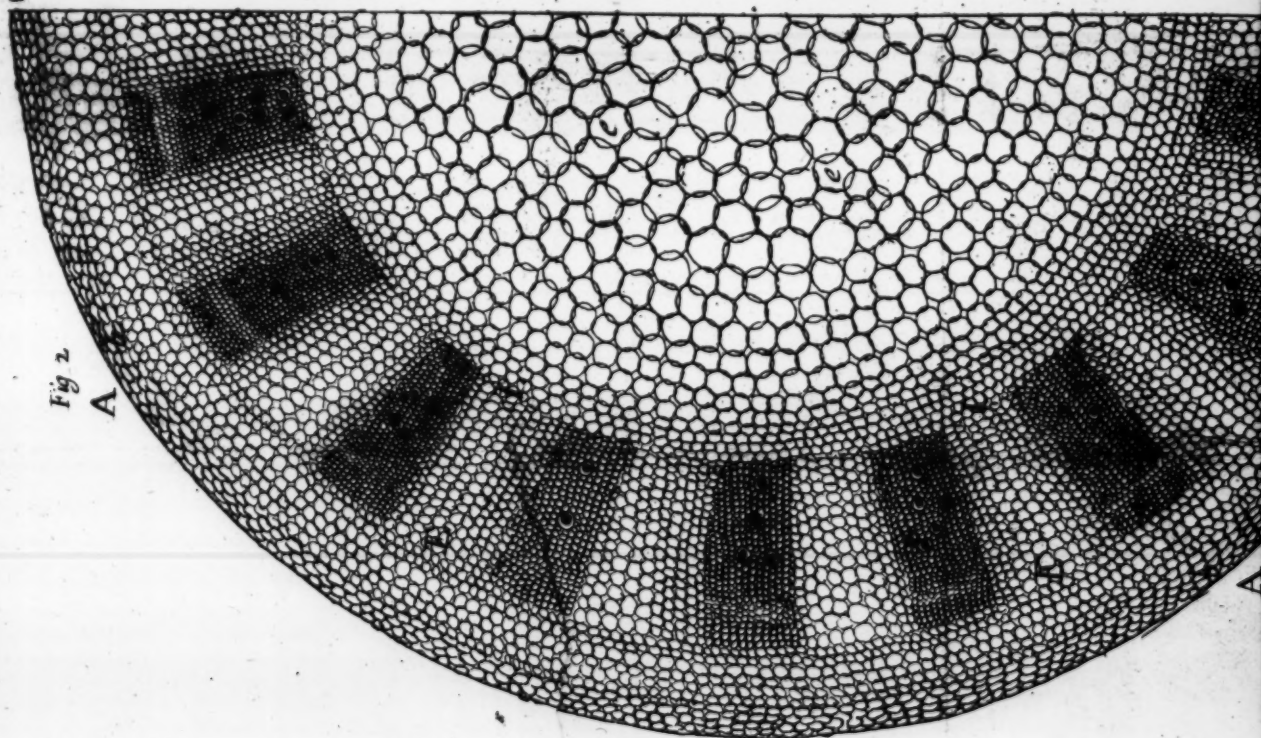


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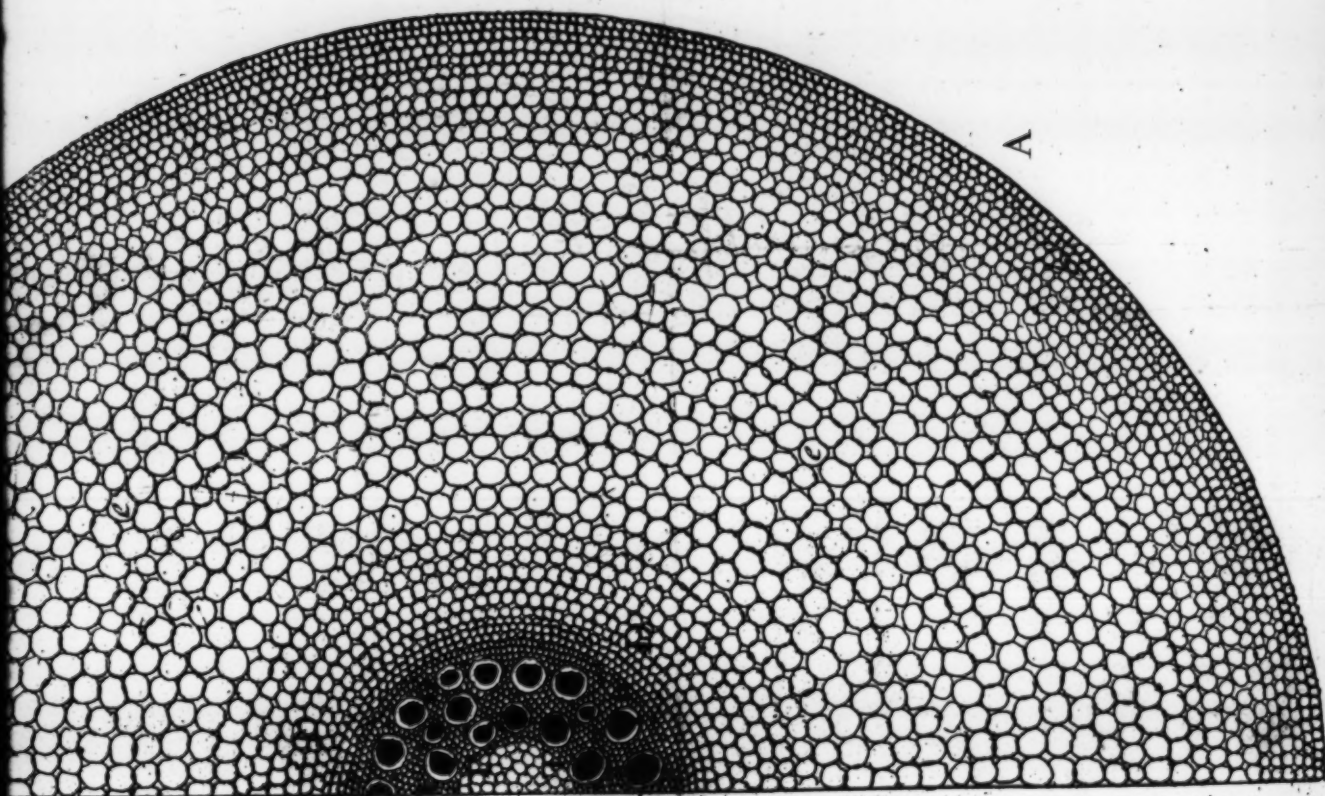
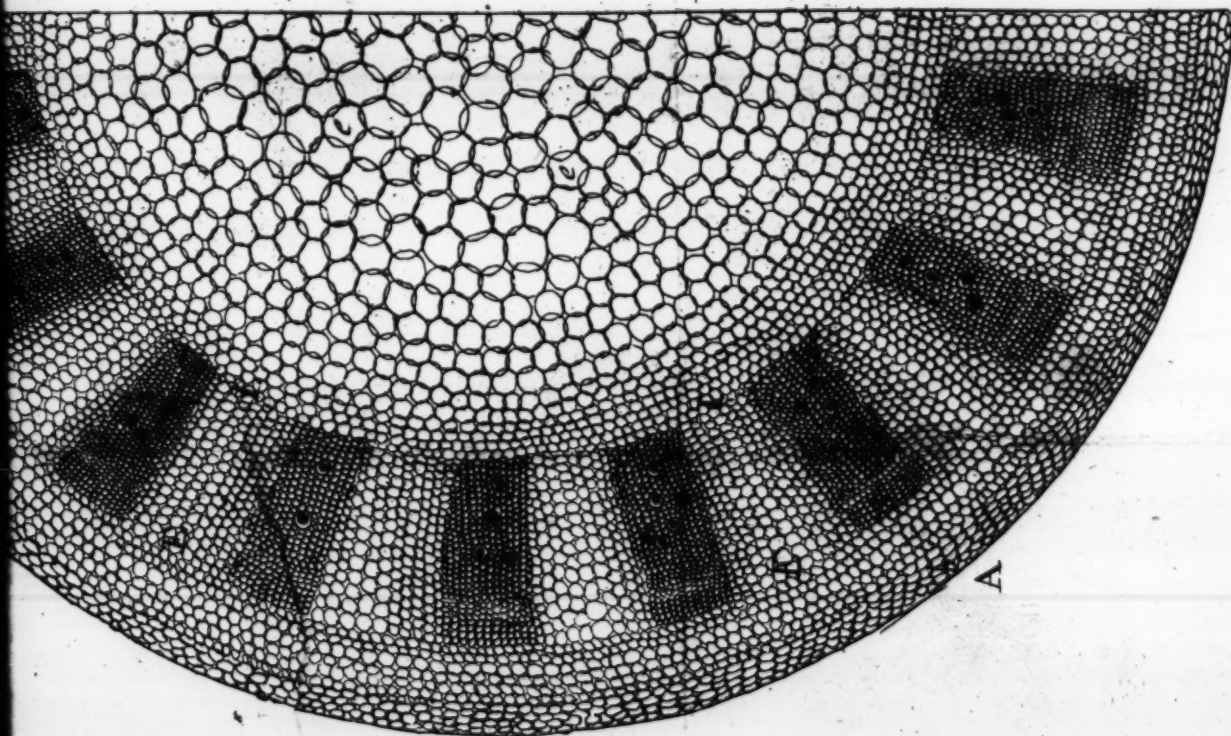
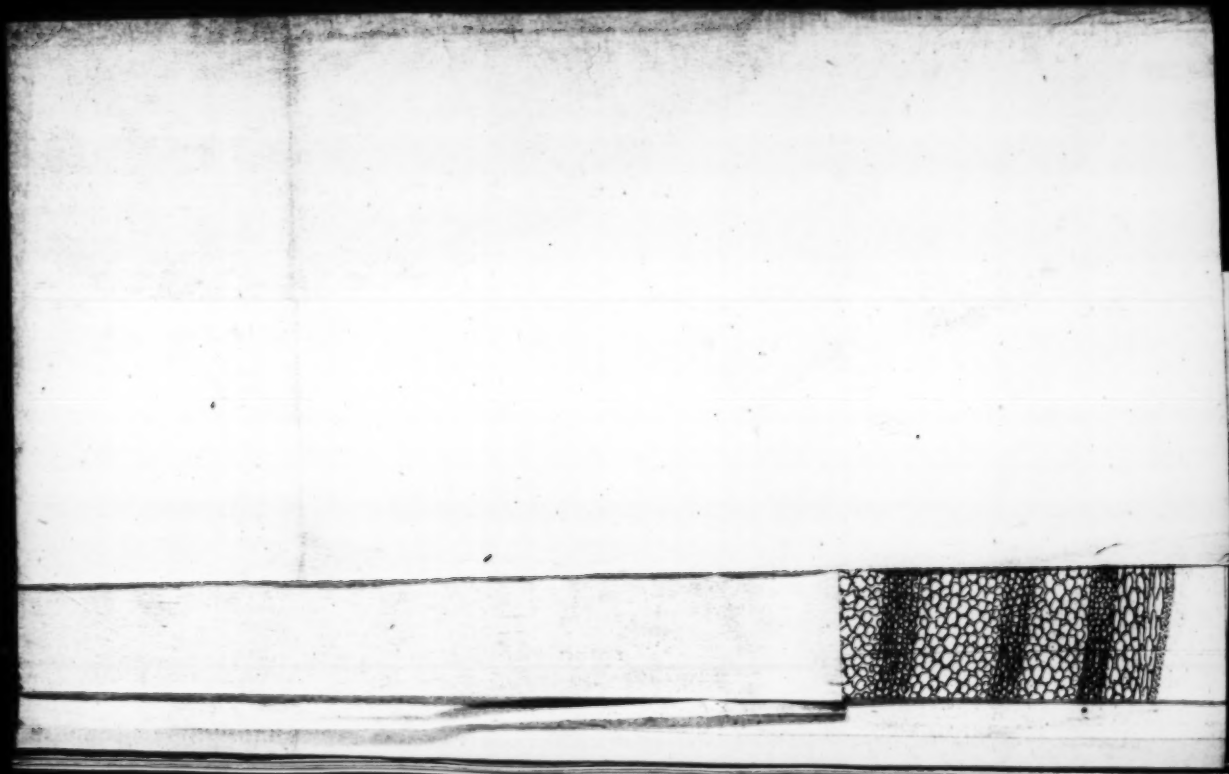


Fig. 2
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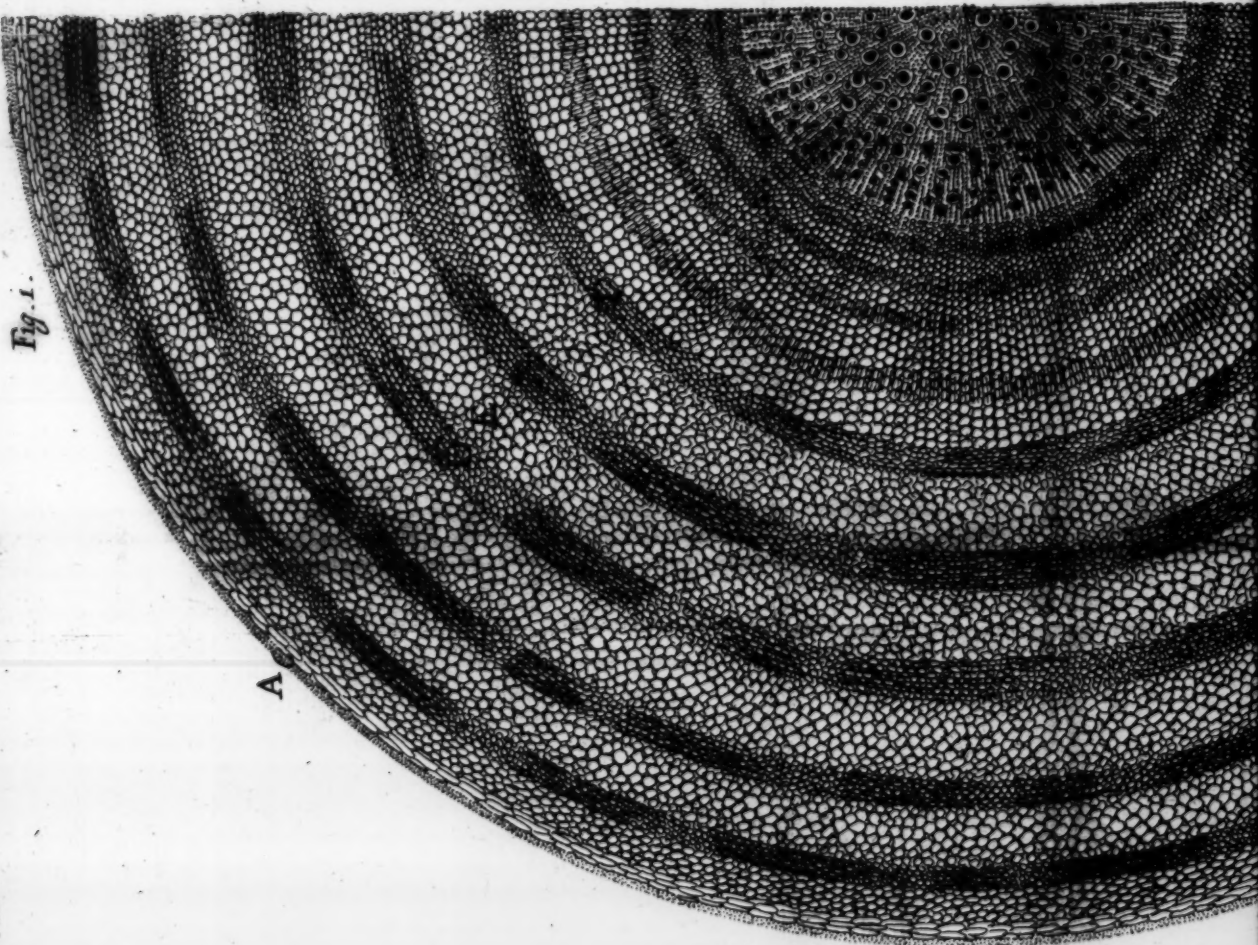


Fig. 2.

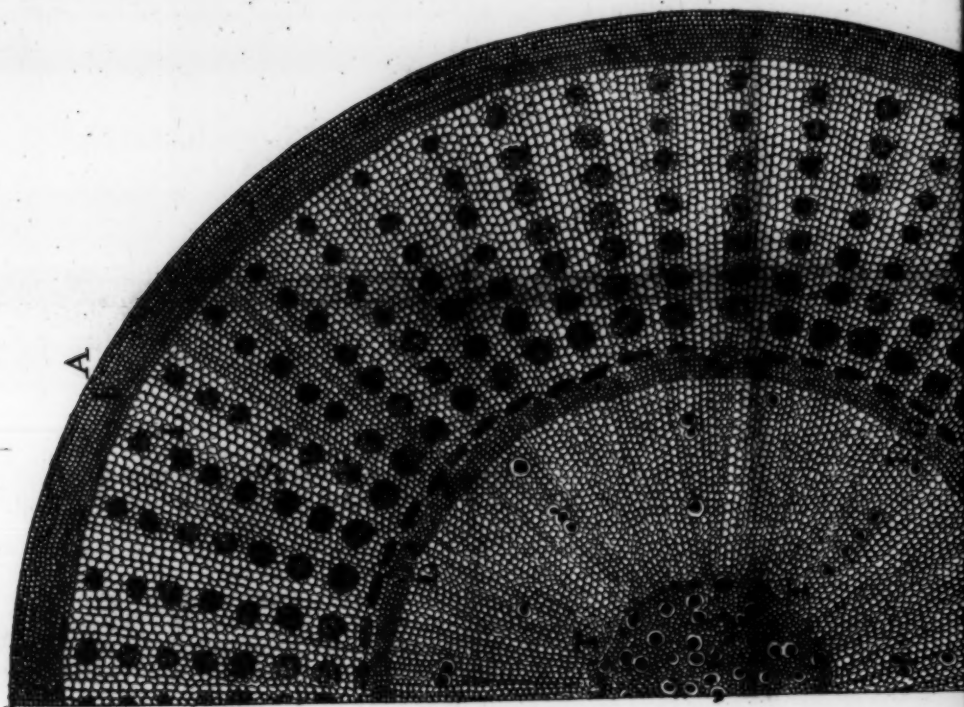


Fig. 2.



Fig. 1.



Fig 2.

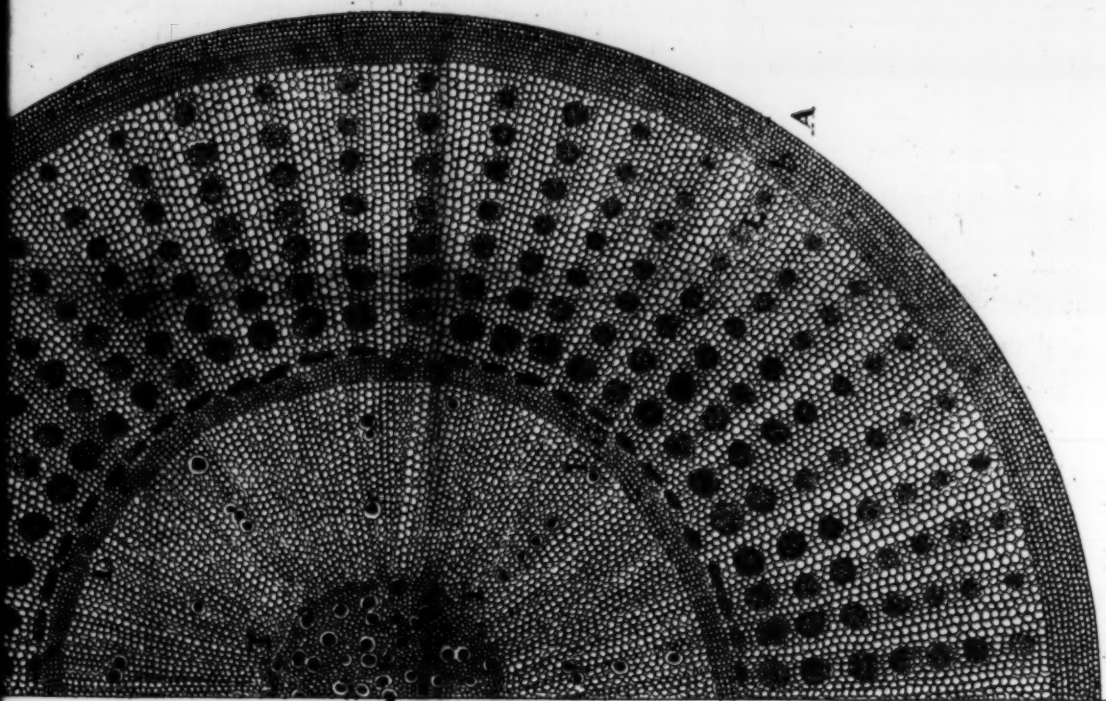


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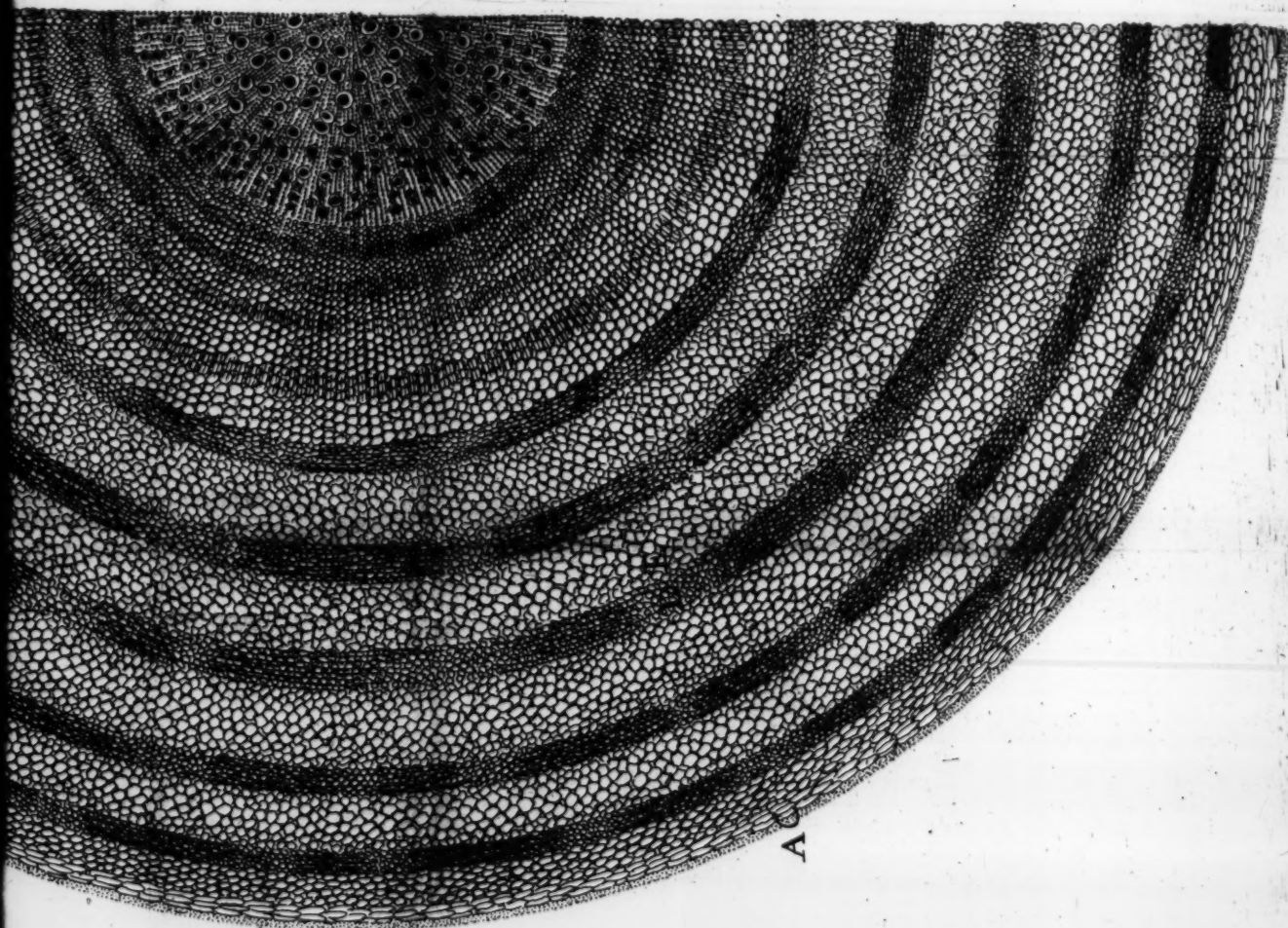




Fig 1

Fig 1

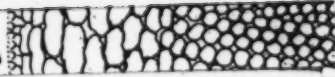


Fig 2

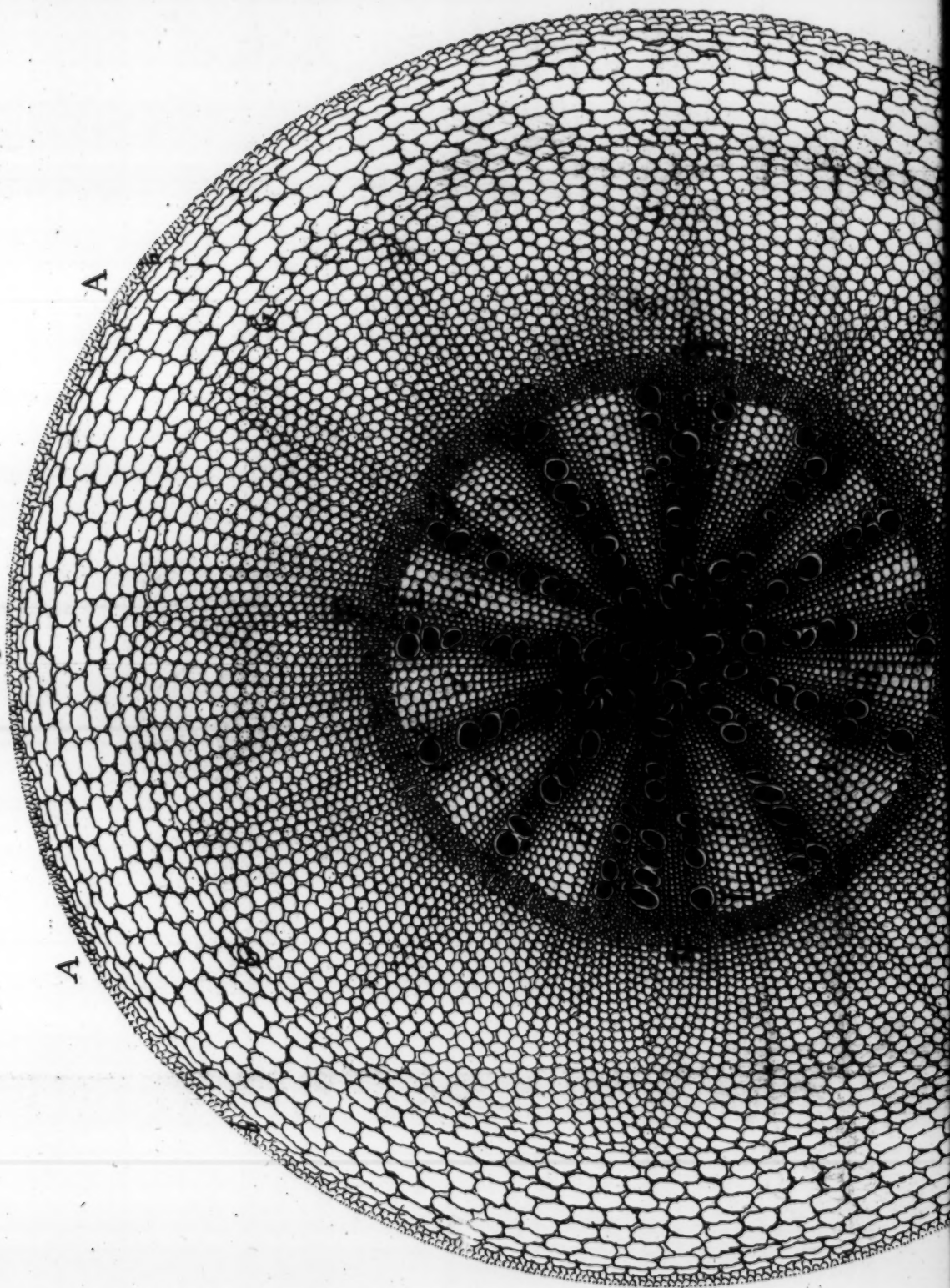


Fig 1



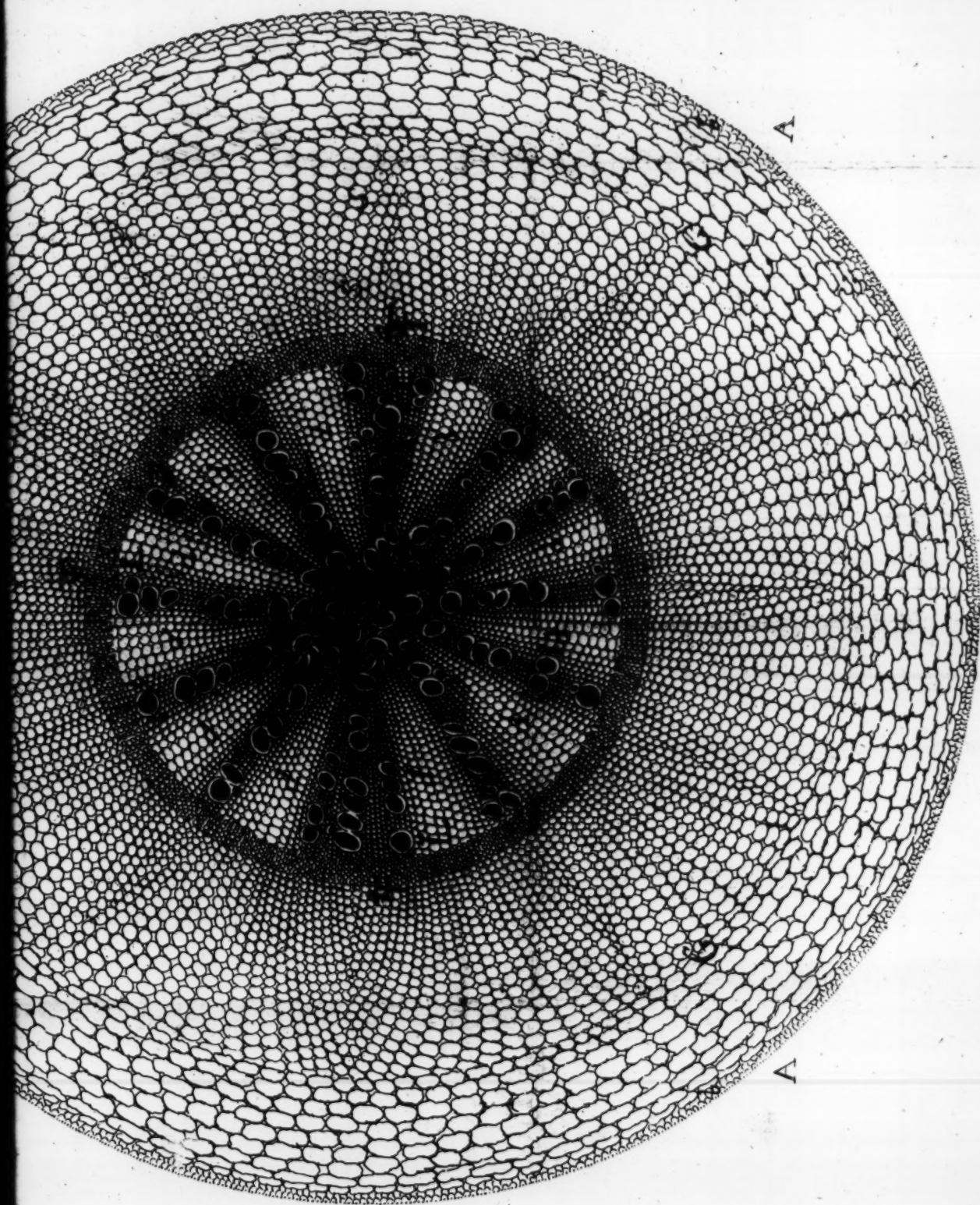


Fig 1





A

Fig. 2

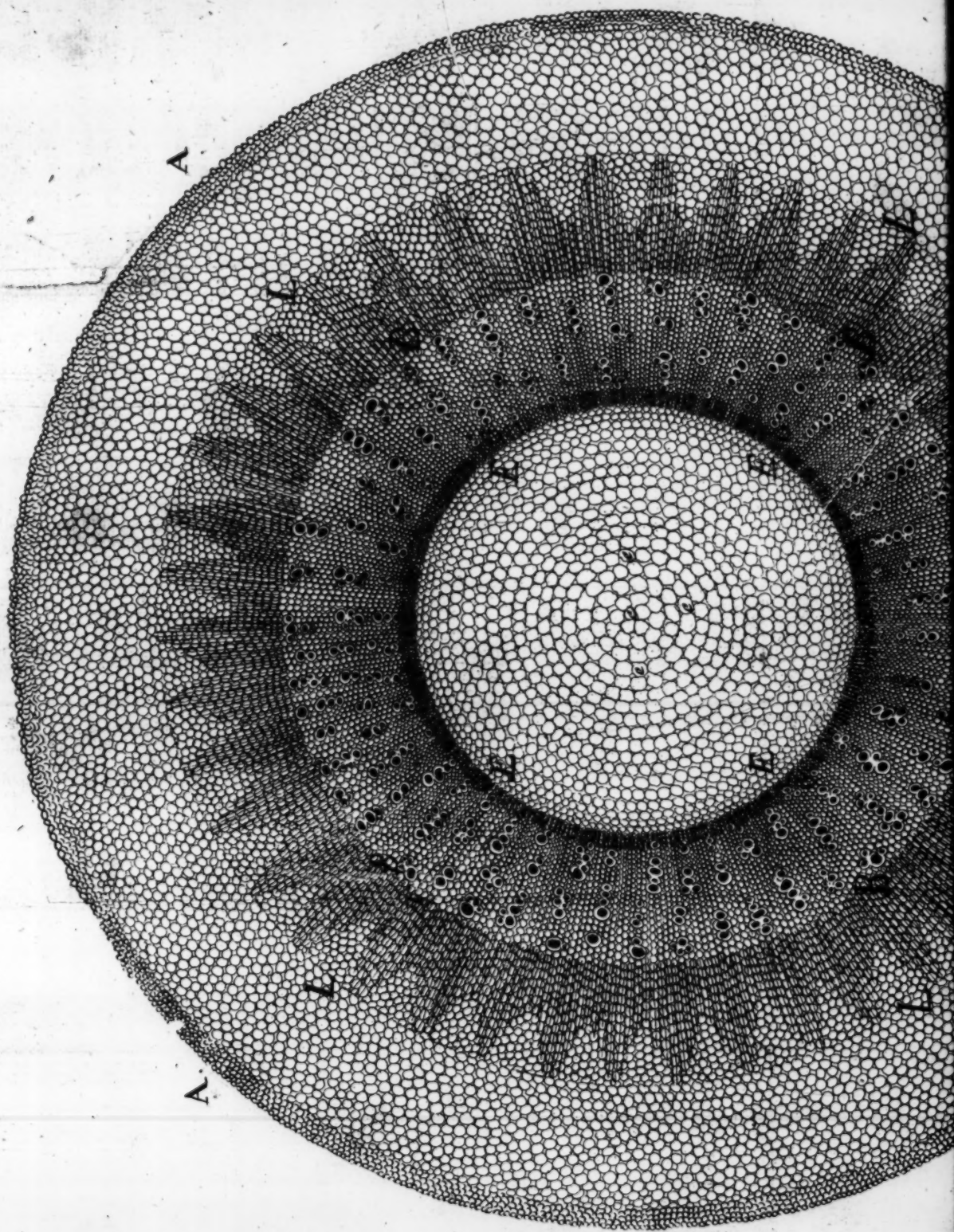


Fig. 1
a a



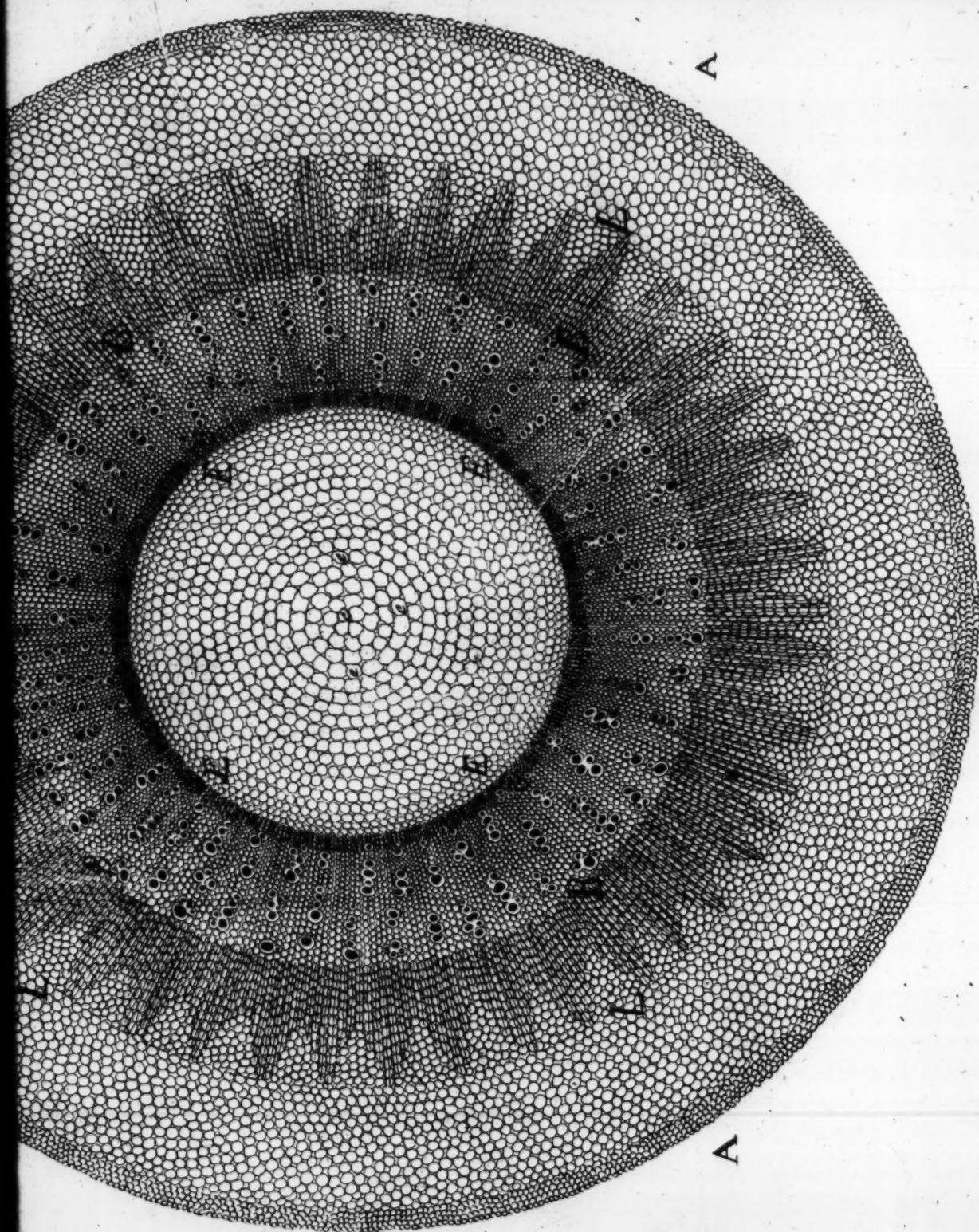
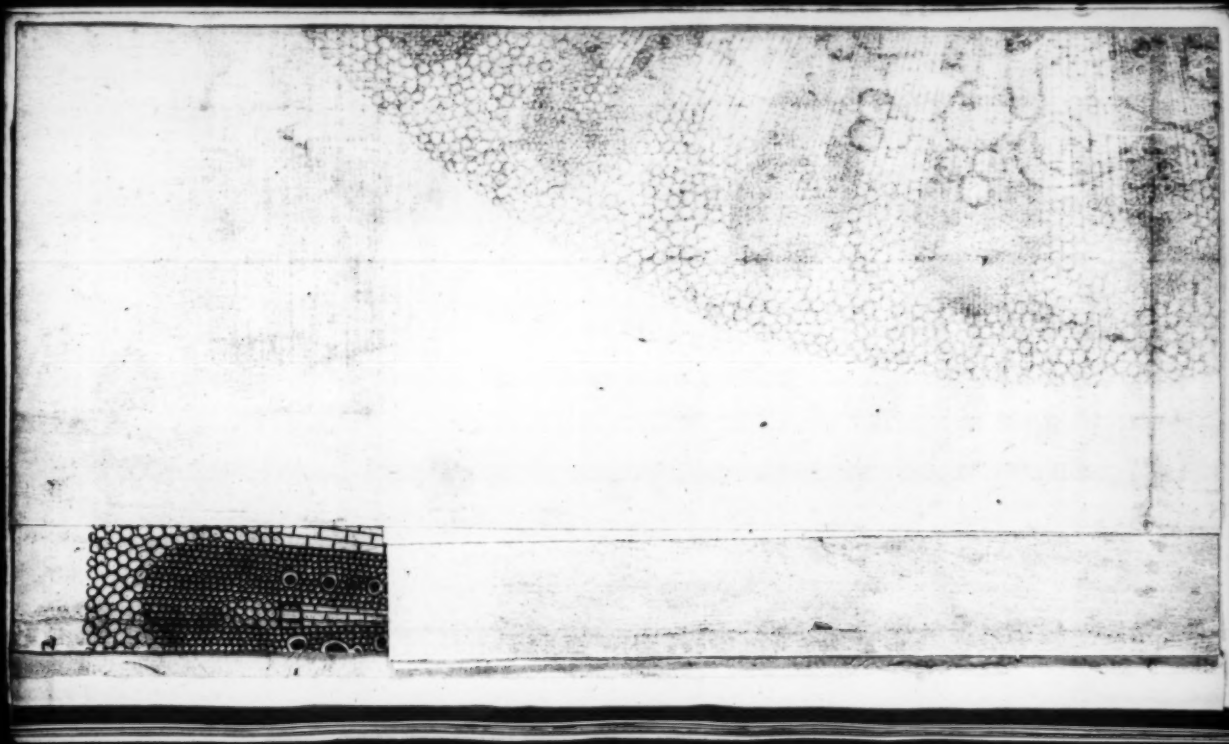
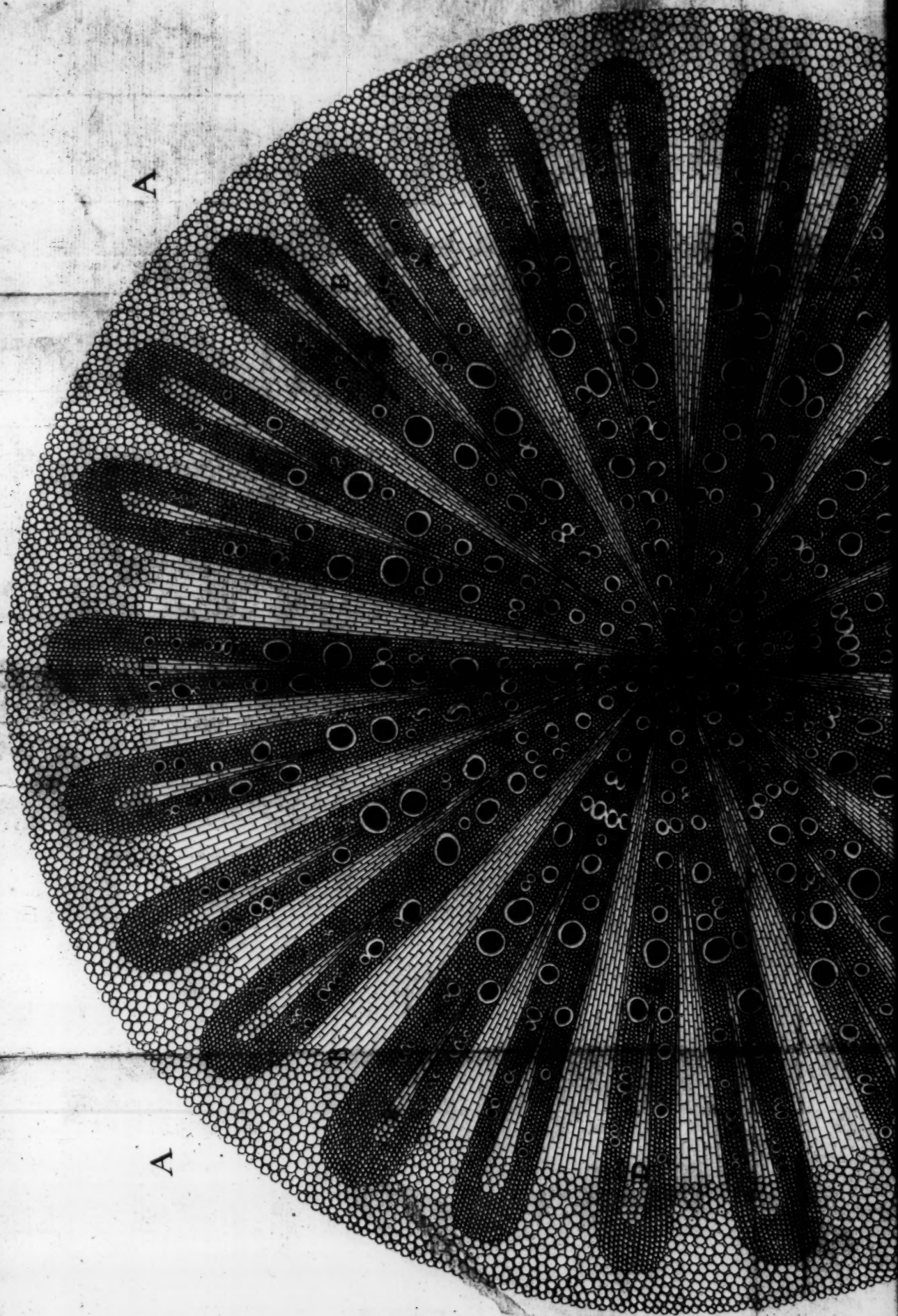


Fig. 1
a







A

A



